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The double tracking of the Chicago & Northwestern Ry. from Madison, Wis., to Baraboo, 40 miles, and the revision and reduction of grades through this portion of Wisconsin, will involve considerable work, as the country is heavily rolling. The contract for grading has been let to Winston Bros., of Minneapolis, who will commence work on the rock sections at once, and on the earth sections in the spring. The contract for masonry has been let to J. A. & Geo. Garden. Mr. H. W. Battin is the engineer in charge of the work, with office at Baraboo, Wis.

A pile wharf 250 ft. long, backed by rock and earth filling, has been built by the Northern Pacific R. R. as an extension of its terminal system at Tacoma, Wash., and the main freight warehouse has also been extended 200 ft., making a building 80 × 600 ft. A new coal bunker for storage is being built, and will be 60 × 400 ft., and 62 ft. high, equipped with conveyors for loading ships. This has been designed by Mr. Charles S. Bihler, Division-Engineer.

The "commuters' car" has just been introduced into England, the Lancashire & Yorkshire Ry. having established special accommodation for a commuters' organization styled the "Lytham, St. Anne's & Blackpool Traveling Club," which guarantees to take 50 first-class season tickets, each member paying $5 in addition to the price of the ticket. The company has built two special parlor cars for the use of the club, one to be attached to each of the two trains leaving Blackpool at 7:18 and 8:20 a. m., returning from Manchester by the 5:10 and 5:15 p. m. trains. These saloons are divided into three compartments, or rooms, opening into each other, one for smoking, one for card playing, etc., and the other a general saloon with accommodation for 39 passengers.

A Chinese railway, 72 miles long and connecting Pekin with Tien Tsin, has been ordered built, according to a published imperial edict of Dec. 6. The estimated cost is about 3,000,000 taels, and the work will be in charge of Mr. C. W. Kinder, M. Inst. C. E. and M. Am. Soc. C. E., Chief Engineer and General Manager of the Imperial Railways of China.

A course in locomotive engineering, including designing, is to be given in the University of Minnesota, at Minneapolis. It will be in charge of Prof. H. Wade Hibbard, a graduate of Brown University, who has had a practical experience in the shops of the Rhode Island Locomotive Works, and of the Pennsylvania R. R. Co., and has also spent some time in Europe studying foreign locomotive engineering.

The most serious railway accident of the week was a glancing collision at Van Nest, N. Y., on the Harlem branch of the New York, New Haven & Hartford R. R., Jan. 19. A local freight train had left some cars on a sidetrack, the rear car being inside the fouling point. A suburban train struck the car, the engine being derailed and the passenger cars damaged, while the fireman was killed by the crushing in of the cab. A rear collision occurred on a wooden bridge over Mahoning Creek, at Mahoning, Pa., on the Allegheny Valley R. R., Jan. 14. The cars and bridge caught fire, and several oil cars went down with the structure.

The boiler of a locomotive of the Pennsylvania R. R. exploded Jan. 16, while the engine was hauling a freight train near Camden, N. J. The crown sheet collapsed, and the engineman was fatally scalded, but the fireman, though blown out of the cab, was not much hurt.—The boiler of a locomotive on the Delaware, Lackawanna & Western R. R. exploded Jan. 17, while the engine was hauling a freight train near Halstead, Pa. The fireman was seriously injured. Low water is said to have caused the collapse of the crown sheet.—A similar accident to the above occurred Jan. 9 near Rushville, O., on the Toledo & Ohio Central R. R., while the engine was climbing a heavy grade. The fireman was seriously injured.

The works of the Hillsdale, Mich., Gas Co. were destroyed by an explosion of gas on Jan. 13. The rafters of the roof of the retort building were so near the retorts that they caught fire, and the flames set fire to the gas in the purifiers.

The Bozeman tunnel, on the North Pacific Railway, has been on fire since Sept. 13, 1895. This tunnel is about one mile long and is heavily timbered to support the roof. On the date mentioned a fire was started in this timber about the middle of the tunnel, and it spread rapidly in spite of every effort to put it out with water. The ends of the tunnel were finally sealed up to cut off the draft; but on lately examining it the fire seemed to be burning as furiously as ever. It is again sealed up, and the traffic is being carried on by a switch-back line over the mountain.

An explosion of acetylene gas has occurred at New Haven, Conn., Jan. 21. A machinist was experimenting with a valve for regulating the flow of gas from the cylinder in which it was stored at high pressure, when the cylinder burst, wrecking the shop and killing three persons. The building was burned to the ground.

A great snowslide at Silver Bow, near Juneau, Alaska, occurred Jan. 10, killing one man and destroying a quartz mill and other buildings. The slide had a path 600 ft. wide and five miles long.

The advisability of making the Erie Canal navigable by torpedo-boats is being now discussed as a means of defending the Great Lakes in an emergency. To permit the passage of boats like the "Cushing," it is proposed to widen one tier of the 18-ft. double locks on the Erie Canal so as to pass boats of 23-ft. beam. Congress will be asked to appropriate $2,000,000 for this purpose. This widening of the locks would also facilitate ordinary canal traffic.

The Lamb electric towing system has been tested at Tonawanda, on the Erie Canal, and has been reported upon by Mr. C. R. Barnes, the electrical expert appointed for this purpose. The Lamb system consists, essentially, of a stationary cableway supported on ports with an electric motor-carriage traveling upon it, and used in towing a boat or boats. Without going into the detail of the test Mr. Barnes says that as compared with the electric trolley system, tested in 1893, the towing system is the most satisfactory. The latter does away with the necessity of fitting boats with propelling machinery, and saves the space thus wasted in the boats; the wash of the propellers is avoided, and the towage system permits greater flexibility of manipulation, as motors may be coupled together as the service demands. Mr. Barnes recommends the electric towage system as superior to any other yet presented, and as possessing many meritorious features.

The Deep Waterway Commission, appointed by the President to confer with three Canadian Commissioners relative to a deep waterway between the ocean and the lakes, has held its first meeting at Detroit. As before mentioned, the United States Commissioners are James B. Angell, L. E. Cooley, C. E., and John E. Russell. The Canadian Commissioners are O. A. Howland, of Toronto; Thomas E. Keefer, of Ottawa, and Thomas Munro. Two of the Canadian Commissioners are thus distinguished civil engineers of long and valuable experience. This first meeting was devoted to the consideration of plans of procedure.

The New York terminal of the proposed New York and New Jersey bridge over the Hudson has been located between 49th and 51st Sts. and 7th and 8th Aves. by the action of the Sinking Fund Commissioners of New York city. The bridge company expresses itself as satisfied with this decision, and will ask for the approval of the Secretary of War.

Selling municipal franchises to the highest bidder is growing more and more common. On Jan. 7, the city comptroller of New Orleans sold the franchise for an extension of the Canal & Claiborne Street Ry. in that city, for $75,000. The City of Sacramento, Cal., is advertising for sale a 50-year franchise for the distribution of electric current for light, power or heat in that city. Bidders are required to make contracts to the amount of no less than $15,000 for their apparatus within 30 days of the award of the contract, and to supply not less than 600 HP. for sale for public and private purposes in the city within two years thereafter. A maximum price of $10 per month for public street lights is fixed; but otherwise the bidder is free to charge such rates as he pleases. The bids are to be opened on Jan. 27.

The Board of Works, of Newark, N. J., has declined the proposition of the East Jersey Water Co. concerning the construction of a new conduit from the Macopin Reservoir to the Bellevue Reservoir in Newark. The water company proposed to lay a new 48-in. main at an estimated cost of $1,400,000, on consideration that the city of Newark paid half the cost, paid the $500,000 held in escrow and extended the time of taking possession of the plant by the city to 1910. Meanwhile the city was to have what water it needed and the company was to sell the rest. Chief Engineer Herschel, in a recent interview, says that he has found a fine coating of algæ in the riveted steel conduit, and to this he ascribes half of the shortage in carrying capacity; he still charges the other half to the mistake of authorities as to what a long riveted steel conduit would carry.

For the reconstruction of the sewerage system of the City of Mexico, a despatch from that city, of Jan. 5, says "that it is probable" that the National Bank of Mexico will issue a popular loan of several millions. The drainage canal will be completed in about six months and work upon the sewers will then be in order, as they are badly needed.

The iron bag-holder for street sweepers, invented by Mrs. Waring, wife of the New York Commissioner of Street Cleaning, appears to be simply a modification of a device long used in Paris for exactly the same purpose. In Engineering news of Jan. 25, 1890, will be found an illustration of the French bag-holder, with a full description of its use. It is cheaply made of light wrought-iron, has a pair of low wheels, instead of the high ones of Mrs. Warings proposed machine, and possesses the additional advantage of holding two bags instead of one. The bag-removal system for street sweepings, lately urged as a new thing in New York, has likewise been used for a long time in Paris, and it certainly has advantages in expeditious and cleanly removal.

A street tunnel scheme is being discussed by the town of Union and the township of Weehawken, N. J. The purpose is to provide a quicker and easier approach to and from the West Shore Railway ferries than is afforded by the present circuitious route to the top of the hill. The proposed tunnel would start at the ferry, and by an ascending gentle grade connect directly with the higher ground. The tunnel would be about 1,000 ft. long and be wide enough for sidewalks, street railway tracks and a driveway. Connected with the tunnel scheme is another for the repartition of the town and township mentioned, which would require legislative action.

The passenger and vehicle traffic upon Broadway, New York, has entered into the rapid transit investigations now in progress. Mr. S. E. De Witt testified that he had spent three days, at different points on Broadway, counting the vehicles and foot passengers. At a point between 21st and 22d Sts., between 7 a. m. and 7 p. m. of Dec. 14, he counted 6,510 passing vehicles, and 14,400 persons using the east sidewalk, and 53,307 passing on the western sidewalk. On Dec. 16 he took his stand between Chambers and Vesey Sts., down town, between 11 a. m. and 7 p. m. he counted 5,150 vehicles; and between 7 a. m. and 7 p. m. 38,895 people passed down the east sidewalk and 41,530 down the west. On Dec 17 he was between Fulton and John Sts. and for the 12 hours he counted 8,630 vehicles and 39,360 people on the east sidewalk and 50,600 on the west. For the whole of Broadway thus counted the general average would be about 634 vehicles and 7,183 people passing per hour.

A law limiting the height of buildings in New York city in proportion to the width of the street upon which they abut is favored by the New York Chamber of Commerce. A late report to that body suggests that all buildings over 80 ft. high shall not occupy more than 80% of the lot owned, a restriction now applied to tenements; that at least two fire-proof staircases shall be provided, and all air and elevator shafts shall be encased in brick walls and lighted from above. No limiting height is fixed; but the report calls attention to the fact that in Berlin the height is limited to the width of the street; in Paris, to 50% in excess of street width; in Chicago, to 130 ft., and in Boston to 2½ times the width of the street.

The Browning machine gun, of .236 caliber, has been adopted by the U. S. Navy, and 50 of them have been ordered from the Colt Arms Co. This is a gas-operated, breech-loading gun, with the cartridges fed from the rim of a cylinder, allowing great rapidity of fire. It can be fired from a mount or from the shoulder. The inventors are John M. and Matthew F. Browning, of Ogden, Utah and it is otherwise known as the Colt gun. It belongs to the class of guns in which the gases generated at each explosion automatically and successively operate the breech mechanism. After firing the first shot the work of the operator is confined to feeding the cartridges and aiming the gun.

100-TON DERRICK AT THE AVONDALE MARBLE QUARRIES, CHESTER, PA.

A derrick with a safe lifting capacity of 100 tons has recently been erected by the Avondale Marble Co., of Avondale, Chester Co., Pa. This derrick can lift or deposit its full load at any point within a radius of 80 ft., and can handle smaller loads, up to 87½ ft. The operations of raising and lowering the boom, raising and lowering the load and rotating the derrick are all performed by steam power, and these operations can be conducted simultaneously, or separately as desirable.

The power is applied from a large, specially designed capstan with its shaft directly connected with the shaft of a 40 HP. stationary engine. Upon the capstan shaft are paper friction-pulleys, and the winding-drums are set in motion by band-wheels brought to bear upon these pulleys by a system of cams and levers. The main hoisting drum is geared for a full load of 40 tons on a high single line to a speed of 12 ft. per minute; and for loads up to 10 tons on a single line the speed can be changed to 48 ft. per minute. The boom-hoist is geared to a speed of 70 ft. per minute; and with 7 parts of rope between mast and boom the full load can be raised at the rate of 10 ft. per minute. The mast is rotated by means of a "bull-wheel" 12 ft. in diameter attached to the base of the mast, and a complete revolution can be made in three minutes.

The main hoisting rope runs directly from the capstan around a sheave in the foot-block of the derrick and then through the center of the mast to another sheave turning on the same pin that holds the boom socket. This rope finally passes up the boom, over several trolleys, and over the sheave at the end of the boom to the load. The boom hoist runs from the capstan to a tackle block back of the capstan house, and then over this house to the top of the mast; there it passes over a sheave in the center of the mast to the sheave in the boom-head, and over two triple blocks to the boom-end. By this arrangement the derrick can make a full revolution without twisting the two ropes, as was usual in the old method of having both ropes enter the foot of the mast.

All sheaves are located in the main castings, leaving the timbers practically uncut; and to do this at the outer end of the boom an ingenious arrangement called a "follower" is employed. This "follower" is made of two iron spools between which the rope passes as it leaves the sheave; the pins upon which the spools turn are fastened to arms rotating on the sheave pins, and the main hoisting rope is thus kept on the sheave in any position. The guy-cap rests upon ball-bearings and all sheaves are made of phosphor bronze and bushed.

The general dimensions of this derrick are as follows: Length of mast, 105 ft. 6 in.; length of boom, 90 ft. 6 ins.; the mast is 31 ins. square at the base, and 26 ins. in diameter at the top; and the boom is 25 and 21 ins. in diameter at the two ends. The mast-socket is 30¼ ins. in diameter by 26 ins. deep, and the mast-hood is 24⅝ ins. in diameter by 26 ins. deep. The boom-socket is 24 ins. in diameter by 23½ ins. deep, and the boom-hood is 25 ins. in diameter by 21¼ ins. deep; all these being inside measurements. The guy-cap is 48 ins. in diameter, with eight 1¾-in. best galvanized rigging cable guys. The main hoisting rope is 1½ ins., the boom fall is ¾ in., and the rotating rope is ⅝ in. in diameter, all made of the best crucible steel wire. The total length of wire rope connected with this derrick is 5,550 ft.; the guys alone requiring 3,000 ft. The derrick castings weigh over 7 tons, and the timber used is Oregon pine. The large gear-wheel on the main hoisting drum of the capstan is 72 ins. in diameter by 8. ins. face; and the large band-wheels are each 48 ins. in diameter by 14½ ins. face.

This derrick is being used in developing a deposit of white marble owned by this company, now topped by stone extensively used for a number of years for coping, bridges and buildings. Tests of this superimposed stone show an average crushing strength of 18,097 lbs. per sq. in., with little absorption, and great transverse strength. One of the views here presented shows the channeling machines at work, and the character of the rock quarried; while another view well exhibits the capacity of the quarry for large dimension stone. These quarries are operated wholly by machinery, no dynamite or explosives being used. After being cut by the channeling machines in two directions the blocks are "raised" by "plug and feather," so that sound stone is insured. As the stone lies at an angle, a contrivance known as a "balance-car" is employed in making the "cross-cuts." This car, shown at the top of Fig. 3, carries the "channeler" on a track parallel to the cut, and is controlled by a cable passing

Fig. 1.—100-Ton Derrick, Avondale Marble Quarry, Chester Co., Pa.

over a pulley at the top of the car in such manner as to counteract the effect of the incline and to enable the channeler to operate as effectively as if upon a level.

Mr. R. H. Hepburn, the President of the Company, writes that though these quarries have been opened for over 100 years, and the stone has been extensively used, the presence of commercial marble of a fine quality beneath was not suspected until he found it by exploring with a diamond drill. As the marble deposit is uncovered most of the few heads tighten and finally disappear, leading him to suspect a deposit practically solid throughout. The stone shown in Fig. 2 is 31 ft. 2 ins. long, 7 ft. 2 in. wide, and 1 ft. 6 in. thick, and it was split off by plug and feather from a mass of the same length and width, but 8 ft. thick. This stone comes from the super-imposed deposit, and Mr. Hepburn states that drill marks made 100 years ago and still showing sharp and intact edges attest the ability of this stone to withstand weathering.

STORAGE BATTERIES IN CENTRAL STATIONS.*

By Maurice Barnett.

Two years ago there was only one important storage battery plant in use in a central station in the United States, and station managers were not seriously considering the installation of this form of accessory apparatus. During the past two years very large battery plants have been placed in New York city, Boston, Mass., and Lawrence, Mass., by local Edison companies, while two battery installations have been made in Merrill, Wis., and Anaconda, Mont., in connection with railway power plants. Since the first installation was completed at Lawrence, Mass., the battery capacity has been doubled, and it is understood that the advisability of increasing the capacity of some of the other stations in the same way is conceded. Negotiations for storage plants for other central stations have been carried on for some time and will probably end in [our] seeing the number of existing battery plants very greatly increased.

The reasons for the change of attitude of electrical engineers and station managers toward the storage battery are as follows:

1. Litigation no longer stands in the way of the use of any of the standard types of batteries, as one large company has now obtained control of this business by securing the right to manufacture in the United States storage batteries of all the important types heretofore developed. It has also obtained control of valuable foreign patents covering the manufacture of the "chloride accumulator" and the "Tudor" battery.

2. The application of special types of batteries to special kinds of work has resulted in a vastly improved performance of battery plants in meeting the exigencies of station work. This refers specially to the performance of the battery in acting as a reservoir for storing the energy represented by the difference between the average and the maximum load, as a regulator of pressure on circuits subject to varying demands and as a transformer utilizing high voltage charging currents and discharging at any lower voltage desired.

3. A plant having part steam power and part storage battery is cheaper than an all steam power plant would be for the same work.

4. The use of batteries in sub-stations frequently permits a saving in conductors between the central and the sub-station.

According to an article in the "Railway World" of Nov. 12, 1895, the first accumulators used in connection with a railway power station were those employed in the plant of the railway between Zurich and Hirslanden, Switzerland (described in the "Elektrotechnische Zeitscrift" of June 28, 1894). According to report the dynamo delivers current under a constant load, the accumulators being charged or discharged as load on the line is less or greater than the output of the dynamo, and there were automatic means for the cutting in and out cells to keep the voltage constant. Results showed that by means of the accumulators a saving was effected of 2.2 lbs. of coal per hour, amounting to nearly a ton per day, or $2,500 a year. The cost of accumulators, installed complete with accessory apparatus, was $7,400. Allowing for interest and depreciation the battery paid for itself in four years by saving in coal bills alone. The saving was effected by reason of there being no necessity for keeping a second boiler and steam engine in reserve, and that by this arrangement the power plant ran at its highest efficiency. It was furthermore developed that the first cost of combined steam power and battery plant was less than cost of total steam power plant would have been for the same work.

Two interesting battery applications were recently made abroad in the power plants of the Douglas & Laxey Electric Ry. and the Snaefell Mountain Electric Ry., both in the Isle of Man. The former line requires a current of 150 amperes at 500 volts to carry a car up the 8⅛% grade at nine miles per hour. The Snaefell Mountain battery plant consisted of 246 special cells of the chloride accumulator type. At 550 volts the battery furnished 176 amperes for 3 hours; 112 amperes for 6 hours; 84 amperes for 9 hours, and 72 amperes for 12 hours. The line is bound to run two cars a day each way every day of the year, and as it would not pay to keep the power-house in operation just for this load the practice was adopted of charging the battery once a week and allowing it to carry the whole load for the other six days.

In the Germantown plant the battery installation is used to carry the peak of the load and also the minimum load. Speaking of this latter function, Mr. Charles M. Allen, the superintendent, says:

> We do not have sufficient day load to pay us, . . . and it is here the battery comes to our relief. Before we used the battery the loss on our day circuits was most discouraging. By the use of the battery we have wiped out this loss, and can show some profit besides. We now shut down the machinery in the early morning and the battery carries the entire load until nearly dark; then, after midnight, while the load is light, but while we must still run our city lights, we charge the battery, and it is a fact noticed by our engineer, as shown on his reports, that he uses about the same quantity of coal on nights he does not charge the battery as when he does.

The maximum output of an electric lighting plant is limited to 1¼ hours or at most to 4 hours a day, and in designing a central station the engineer must choose between several alternatives. If he puts in complete steam power plant of most modern type to handle the maximum load, more than half of the plant will be idle the greater part of the day, from which it will follow that the profits of lighting will be greatly reduced by large interest charges and heavy stand-over losses in the boilers. Such a plant, besides being very expensive, has no reserve capacity in case of accident. To off-set the ques

Fig. 2.—Block of Stone, 31 ft. 6 ins x 7 ft. 2 ins. x 1 ft. 6 ins. in Avondale Quarry.

* Abstract of a paper read at the annual meeting of the Northwestern Electrical Association at Milwaukee, Wis., Jan. 15 to 17, 1896.

tion of large first cost it has been proposed to introduce the best type of economical machinery to handle the average output with some less expensive apparatus to take care of the overload. For the latter work Mr. Perry has proposed gas engines to drive extra dynamos. Such a plant, while avoiding the stand-over losses to which a boiler plant is subject and showing smaller interest charges, is open to the objection that amortisation expenses of cheap machinery besides loss in efficiency, counterbalance the saving in interest. Nor has such a plant any reserve capacity in case of accident. Mr. Perry's suggestion of gas engines would be valuable were it not for the fact that every failure to ignite would appreciably alter the speed of the dynamos, as gas engines cannot maintain their speed when obliged to make two revolutions on a single explosion. As a matter of fact in gas engine plants a storage battery is considered almost absolutely essential as a regulator and as a reserve against break down.

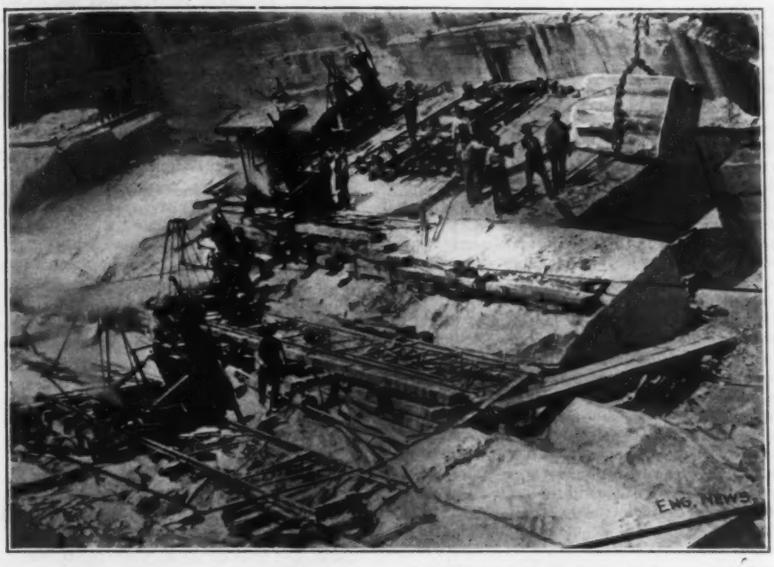

FIG. 3.—MANNER OF WORKING OUT STONE IN THE AVONDALE QUARRY.

Lastly there is the combination of a steam power plant to handle the average output and a storage battery to take care of the overload. Storage batteries of central station type can be installed for this work for about half what a steam power plant would cost—making a plant half steam power and half storage battery cost only three-quarters what an all steam power plant would for the same work. Mr. C. L. Edgar, General Manager of the Boston Edison Illuminating Co., which is the owner of the largest storage battery plant in the world, has put himself on record as to the accuracy of the above figures.

The maintenance cost of such a battery, generally speaking, should not exceed that of direct generating machinery. In work of this kind, therefore, the storage battery has undoubted economic value, as it suggests the way of designing a central station that will be only moderately expensive, and which will be safeguarded against stoppage arising from accident to the generating machinery.

Opinion is divided as to the economy of using storage batteries to carry the minimum load. Abroad, where the motor load is insignificant, the minimum demand for power lasts for half a day. It is thus possible to get along with a single shift of men, and something is also saved by drawing the fires, banking the boilers, or otherwise practice, when it is not intended to run the plant, and its is considered more economical to let the battery take care of the minimum demand than to handle it with the direct minimum machinery. In this country the motor load is very important, and the minimum load lasts from only four to six hours a day. A whole shift of men cannot thus be saved. Experiments have been tried in Boston on a large scale with a view to ascertaining the value of a storage battery in this connection, but as yet no definite conclusions have been reached. Undoubtedly there are numerous cases where the minimum load is small and lasts for half a day at least, making it economical to use a battery, and the Germantown plant already referred to is a case in point.

One of the most important and valuable functions of a storage battery in a central station is as a regulator of pressure, as the variation of voltage is perceptibly less when a battery is arranged in parallel with the generator than when it is not. When a shunt-wound dynamo, such as is used in central stations, is running alone, any increase in ampere output will be attended by a fall in voltage. When on the other hand a battery is combined with the dynamo, the moment the pressure falls from a large demand for current on the line the battery begins to discharge and thus augments the output of the dynamo. In other words, the battery acts as a reservoir; when the load on the line is small the battery is charged; when the load becomes heavy the battery begins to discharge, and in so doing performs a doubly valuable function. In the first place it saves the generating machinery from strain, and, secondly, by keeping the pressure constant, makes possible a much higher efficiency both in the station and on the line.

Lastly, we come to the question of the use of storage batteries in sub-stations. In a city which has spread out irregularly it may happen that at some distance from the central station the population is large and that considerable current will be required to furnish adequate light. If the situation is such that it is cheaper to furnish light from the central station than to operate a small power plant as a sub-station the former will be done. The consequence of this will be shown in heavy losses in the line, owing to large currents transmitted, and there will be heavy interest charges for large conductors. If a storage battery sub-station were located in the center of this suburb several economies would be gained. Much smaller conductors would be employed, resulting in diminished interest charges, and a high-tension current would be used in transmission, by which losses on the line would be lessened. These economies are brought about by the ability of the battery to act as a "transformer." In other words, the battery may be charged in series with a high-tension current and discharged in multiple, bringing the pressure at the sub-station down to requirements. On the other hand, a battery may be charged in multiple and discharged in series, by which it will be possible to get along with one dynamo instead of two or more in series. Owing to the flexibility of storage batteries they are specially adapted to working on a three-wire or a five-wire system.

As to the coal consumption in a station consisting of both generators and batteries, the use of storage batteries is sometimes objected to on the ground that there is a loss of 15 to 20% of the watts generated while the battery is being charged. Mr. Edgar, however, says: "The watts lost by the inefficiency of the battery are made up more than four-fold by the better economy of the steam plant. We have taken typical winter days and figured out exactly the cost of running our system with the battery and without, and have proved that the actual coal consumed with the battery is a material amount less than without it."

To recapitulate, storage batteries are valuable in central stations on account of the three-fold function they perform, as reservoirs of energy, regulators of pressure and transformers of high to low or low to high tension currents. In performing these functions they make possible lower first cost in main central station and lower first cost for conductors between this and the sub-stations where batteries may be installed. They are, further, valuable in saving the power and generating machinery from strain and in effecting economy by introducing the factor of high efficiency in the station and on the line.

REPORT OF THE NEW YORK STATE BOARD OF RAILROAD COMMISSIONERS FOR 1895.

The New York State Board of Railroad Commissioners has issued a preliminary report for the year ending June 30, 1895. This report shows gross earnings for the year of $199,198,355, a gain of $1,241,039 over 1894. The gross operating expenses were $136,337,603, a decrease of $702,970, as compared with that of the previous year. The net earnings from operations for 1895 were $62,860,751, with an income from other sources of $7,128,186; the increase in net earnings over 1894 was $1,944,010. The freight movement for the year was 17,849,132,031 ton miles, a gain of 1,475,777,199 ton miles over the previous year. The average freight earnings per ton per mile were 0.735 cts. as compared with 0.766 cts. in 1894, and the average freight profit per ton per mile was 0.259 cts., as compared with 0.229 cts. in 1894. The passengers carried one mile, exclusive of elevated railways, were 3,040,238,561, a decrease of 711,315,409 as compared with the previous year. The average earnings per passenger mile were 2.23 cts., as compared with 1.93 cts. in 1894, and the average expenses per passenger mile were 1.69 cts., against of 1.31 cts. in 1894; the average profit was thus 0.54 cts. per passenger mile, as compared 0.62 cts. in the previous year.

A condensed statement of the condition of street surface roads would stand as follows, as compared with 1894:

	1895.	1894.
Capital stock	$89,693,580	$88,261,928
Funded debt	80,180,423	77,574,729
Unfunded debt	12,356,519	9,216,834
Cost of road and equipment	179,674,265	161,997,474
Gross operating earnings	25,477,227	23,911,025
Operating expenses	16,628,451	15,418,847
Net operating expenses	8,848,775	8,492 177
Dividends	1,993,772	1,577,107

The Board, on the whole, regards the figures for 1895 as indicative of returning prosperity and as warranting the anticipation of much more favorable results for 1896. A comparison of the quarters ending Sept. 30, 1894 and 1895 shows an increase of $3,940,915 in gross earnings and $2,165,698 in operating expenses, making the net increase in the quarter $1,775,217. A detailed comparison indicates that this quarter of 1895 covers a business about equal to the corresponding quarter of 1893, when the World's Fair traffic was at its height. The physical condition of the roads is reported as constantly improving.

Of the 247,844 freight cars owned in the states 51,136 are equipped with air-brakes and 116,004 with automatic couplers of the most approved type. Under the laws of New York, requiring that all new cars shall be equipped with automatic couplers and 20% of all cars owned shall be so equipped annually and 10% fitted with air-brakes annually, the Board believes that all cars owned in the state will be fitted with automatic couplers by Jan. 1, 1898, and with air-brakes by Jan. 1, 1903.

The total killed and injured by railway accidents for three years are as follows:

	1893.	1894.	1895.
Killed	742	723	694
Injured	2,288	1,821	1,125

Of the number killed in 1895 only 60 employes and 1 passenger met death from causes beyond their own control; of the remainder 341 were killed while walking on the track as trespassers. The accidents reported on street surface roads were as follows:

	1894.	1895.
Operated by mechanical power:		
Killed	82	54
Injured	253	214
Operated by animal power:		
Killed	10	5
Injured	42	33

Statistics for steam railways of the State show that only 1 passenger was killed for every 9,511,492 carried, and 1 in every 1,358,784 was injured. The report gives the Pennsylvania record on this head as 1 in 4,325,718 killed and 1 in 204,977 injured. In New York 1 in 742 employes was killed, and 1 in 213 injured; the same record for Pennsylvania railways stands 1 to 432 killed and 1 to 23 injured.

The Board considers that safety in the operation of electric and cable street railways is one of the most serious problems now presented in connection with their management. After discussing the fender question the report again calls attention to the necessity for some device for mechanically regulating the speed of trolley cars, with a speed indicator conspicuously displayed. Such a controlling device is now being experimented with on the Buffalo &

Niagara Falls Electric Ry., and promises success. The use of power brakes is also recommended on surface roads operated by mechanical power, and it is stated that their necessity is conceded by the managers of such roads. The difficulty lies in obtaining a power-brake which will answer all requirements.

A NEW AUTOMATIC TELEPHONE EXCHANGE SYSTEM.

In the ordinary system of telephone exchanges each subscriber has a wire to the central office, and must call up that office to have his wire put in connection with that of any other subscriber with whom he may wish to communicate. A large proportion of the cost of the equipment of telephone plants is

Fig. 1.—Subscribers Telephone Instrument; Callender Automatic Exchange System.

that involved in the costly and complicated switchboards, and a large proportion of the operating expenses of a telephone exchange is involved in the employment of the numerous operators required to make the connections. These facts have led to the invention of automatic exchange systems. In most of these automatic systems the principle has been that each subscriber would have an individual switching mechanism at the central office or exchange, and each subscriber's line terminals would cross and be united to the line terminals of every other subscriber, which would involve an immense amount of complicated work for the connections alone, apart from the apparatus and extra connections for each individual subscriber.

The automatic exchange system devised by Mr. Romaine Callender, of 33 Union Square, New York, is on the percentage principle, in which the exchange has mechanism enough to do the maximum business during the busiest hour of the day, and his system is intended to do away with the operating expenses due to the employment of operators, and to considerably reduce the first cost of installation. The statistics of telephone exchange connections show that the maximum number of telephones in use a one time rarely, if ever, exceeds 20% of the total number constituting the exchange, and in the Callender system, therefore, a percentage of connecting mechanisms is provided instead of an individual mechanism for each subscriber, thus eliminating a large amount of apparatus and considerably reducing the size of the exchange. The connecting mechanisms are for the common use of all the telephones, provision being made by which the turning in of a call by any subscriber individualizes for his own use one of the mechanisms not in use at the time his call arrives. The means by which the subscribers are enabled to interconnect themselves at will comprises special apparatus at the subscriber's station and at the exchange station.

The apparatus at the subscriber's station includes the usual telephone transmitter, receiver and call bell and also a special signaling transmitter consisting of two graduated indicator dials, and numbered from 0 to 9. The general appearance of this apparatus is shown in Fig. 1, and this form of transmitter is used for small exchanges having not more than 99 telephones. For a larger exchange, having any number of telephones not exceeding 999, a third dial is used, while the addition of a fourth dial would increase the capacity to 9,999 telephones. A subscriber desiring to put himself in communication with another subscriber, say No. 36, places the indicator arms or pointers over the proper numbers on the plates, that is to say the left-hand pointer over 3 and the righthand pointer over 6. He then pulls down the lever at the right-hand side of the box and releases it. This completes the operation, as the signaling transmitter automatically turns in the proper signal, and in less than 12 seconds the call bell rings. If the desired communication is effected, one long ring is given, or two rings indicating a "busy" call, if the telephone signaled for is already in use. The operations at the subscriber's end are, it will be seen, very simple and are easily effected, leaving little chance for mistakes.

The apparatus at the exchange station includes the following parts: 1. Selector-connector; 2. Numerical receivers; 3. Progressive switches; 4. Signaling tracks. The selector-connector or circuit selector, shown in Fig. 2, is the main controlling apparatus, its function being to apportion to each call received some portion of the apparatus not in use at the time, after which it contributes directly to the establishment of a connection between the calling and called subscribers. The numerical receivers are for indicating the numbers of the telephones with which connections are desired. The progressive switches are auxiliaries for leading up to the act of connecting, and the signaling tracks, Fig. 3, are used for signaling to the subscribers and for percentage control and clearing out purposes. The operations of these several parts are as follows: When a subscriber turns in a call in the way above described, he puts the selector, Fig. 2, into service, and this device apportions to him some one division of the percentage mechanism used for registering signals. The number of the telephone called for is then immediately registered on the numerical receivers of that division. A circuit-closing agent is liberated and descends the signaling track, Fig. 3, in passing along which it "numeralizes" or selects the number called for and, with the assistance of the progressive switch, seized and individualized to the use of the calling subscriber, it connects the "caller" and "called," if the latter's line is not in use. The call bells of both subscribers are then rung through the further progression of the circuit closing agent along the signaling track. Finally both subscribers are left in undisturbed communication, all of the apparatus having passed out of their control, with the exception of the progressive switch seized and individualized for the "caller" and the connector element connecting the "called" with the "caller." As conversation is effected through the connector, the elements it controls have the largest percentage proportion, 10% being the maximum, enabling 20% of the telephones of the exchange to be in communication simultaneously. The other parts of the apparatus revert to common use as soon as each has served its independent function.

The invention comprises other features of novelty, such as the storing of calls for lines in use at the time of the call arriving, and an automatic recording system for registering the number of connections had by any subscriber. These are not necessary features of a percentage exchange system, but they are readily adapted for use with such a system when considered desirable. The call-storing system acts as follows: When a call is received for connection with some other telephone then in use, that call is stored and a "busy" signal is sent over the line of the signaling telephone. The telephone in use is not affected until its user releases it from connection. As soon as this is done the stored call becomes effective, and a "connected" signal is sent over the lines of both parties to the new connection then made. Many calls may be stored for the same telephone. In adapting this feature it is not necessary to apply it to the whole system as it may be used in connection with any one or more lines entering the exchange. The same remark applies to the connection-recording apparatus, as this can also be used with any desired number of the lines. This latter apparatus is designed for those users who prefer payment for actual use, as in the toll system, and, as the record shows the day of the month and hour of the day, it affords ready means for encouraging increased use of the telephone at reduced rates for those hours of the day during which exchange facilities are not in general use.

The parts of the apparatus in use for only a few seconds at a time are said to be fewer in number than those in use for a longer period, and in this way the full benefit of percentage use is maintained. In order that no incoming signal or call may be lost through an abnormal rise of the call rate, the number of signal receiving mechanisms is made proportionate to the number of calls likely to arrive simultaneously. The signal-receiving mechanism is also made capable of storing a call so that should a call arrive during a busy hour when the system is in full use, this call will be stored or held for a few seconds, long enough to allow some part of the system to become inoperative, and thus enable the stored call to be operative. By increasing the time for making connections from 12 seconds to 18 seconds, a gain of 50% in the capacity of the exchange is obtained without any additional mechanism. The system may be seen in operation in the Decker Building, 33 Union Square, New York city.

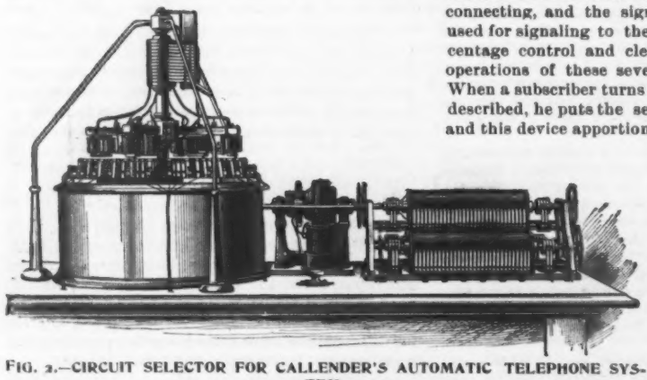

FIG. 2.—CIRCUIT SELECTOR FOR CALLENDER'S AUTOMATIC TELEPHONE SYSTEM.

FIG. 3.—SIGNALING TRACK FOR CALLENDER'S AUTOMATIC TELEPHONE EXCHANGE SYSTEM.

Berlin's first electric railway, on the overhead trolley system, was recently opened for traffic. It connects Gesundbrunnen and Pankow. The work was authorized in May, 1894. It is a double track line, nearly 2 miles long; the cars carry 18 passengers inside and 12 outside; the speed ranges from 9 to 12 miles per hour, and the uniform fare is 2½ cts.

THE WATER-WORKS OF CURAZOA.

The island of Curazoa, one of the Dutch West Indies, lies in the Carribean Sea, 46 miles north of the coast of Venezuela. It is about 50 miles long and 8 miles wide, with its population chiefly clustered about its chief city, which is thoroughly Dutch in appearance. Mr. E. Sherman Gould, M. Am. Soc. C. E., who recently visited this island professionally, gives us the following general account of what may be called its public works, and incidentally remarks upon the enterprise of a native of the United States, Capt. L. B. Smith, formerly American consul at Curazoa. This Captain Smith supplies the city with ice and coal, designed and built and operates its water supply, connected the two sides of the bay by a pontoon bridge, also devised and erected by himself, and seems to have generally made himself useful to this community; not, however, without gain to himself, as he owns the concessions controlling these various operations.

PONTOON BRIDGE ACROSS THE HARBOR AT CARAZOA, CURAZOA ISLAND.

The pontoon bridge referred to is 700 ft. long, made of pontoons 30 ft. long × 20 ft. wide and spaced 30 ft. apart, c to c. For the passage of vessels a 400-ft. draw section, is provided, operated by an engine hauling upon two properly located cables attached to the shore. Previous to the coming of Capt. Smith the people of Curazoa had been dependent upon rain water collected in cisterns during the rainy season, which lasts from September to January. As there was at times a scarcity of water, owing to failing rainfall, Capt. Smith, in 1892, commenced sinking artesian wells, and early in 1893 he had five wells, each 6 ins. in diameter and from 150 to 200 ft. deep, yielding a daily supply of 10,000 gallons of excellent water. He sank these wells at his own expense under an agreement that, if successful, he was to have a concession granting him the sole right to supply water to the city of Curazoa for 25 years, after which time the city had the right to purchase the plant at a valuation. Under this concession water is now sold at 1ct. for five gallons.

A distribution system of 4, 6 and 8-in. cast-iron pipe has already been laid, about two miles in aggregate length, with service pipes to houses and a meter system. Included in this system are 700 ft. of 8-in. ball-and-socket pipe laid across the bay, and alongside the pontoon bridge mentioned in 90 ft. of water. Here again Capt. Smith was his own engineer and general manager. The water in the artesian wells rises to within 20 ft. of the surface and is then pumped by windmills into two tanks, from which it is lifted by a Worthington duplex pump to a stand-pipe, 40 ft. high and containing 100,000 gallons, located at an elevation of 150 ft. above sea-level. The boilers and pumps are placed in a substantial power house of brick, stone and iron, 80 ft. long by 40 ft. wide, and 20 ft. high. These liberal dimensions were adopted because Capt. Smith has already obtained the concession for providing electric light and power to the city, and he proposes to install this plant in the power house already built.

TUNNEL SECTIONS OF THE NASHUA AQUEDUCT FOR THE METROPOLITAN WATER SUPPLY.

(With Inset)

In our issue of March 7, 1895, we described in considerable detail, the works proposed for supplying with water the city of Boston and the suburban cities lying adjacant to it within a radius of some ten miles. During the past year rapid progress has been made with this enterprise, as our readers know, and bids are now asked for building the first sections of the aqueduct which is to convey the water from the great Nashua reservoir, 50 miles west of Boston to the distributing reservoirs near the city. These sections include practically all the aqueduct which will be in tunnel. The drawings on our inset sheet give the principal particulars as to dimensions, material, etc.

The following extracts from the specifications comprise the features of special interest:

Section 4. Borings and test pits have been made on portions of the line to ascertain the nature of the underground strata, and the results are shown on the plans. Should the character and extent of the various materials be found to differ from what is indicated, the contractor shall have no claim on that account, it being expressly understood that the commonwealth does not warrant the indications of the borings or test pits to be even approximately correct.

Sec. 7. The shafts shall be known as "large" and "small" shafts. The large shafts shall have a horizontal area of not less than 121 sq. ft. and the small shafts a horizontal area of not less than 63 sq. ft. in the clear of all rock, and of all framing or other supports, except the necessary cross-bracing used in maintaining the sides of the shafts. The large shaft must contain two cages. The cross-bracing must be so arranged as to leave ample room for all the necessary water, steam, air or other pipes; and all constructions in the shaft must be so arranged as not to interfere with the convenient use of instruments and appliances for the alinement of the tunnel. The clear distance across the shaft lengthwise of the tunnel shall not be less than 9 ft.

Sec. 8. The contractor shall be responsible for properly supporting the sides of the shafts so as to prevent bulging or caving, or danger from falling rocks; if, however, the engineer is of opinion that at any point sufficient or proper supports have not been provided, he may order additional supports, or order them modified or replaced at the expense of the contractor, and the compliance with such orders by the contractor shall not relieve him from his responsibility for the sufficiency of such supports Cages must be used for the hoisting of men and material, during the construction of the tunnel, and full precautions must be taken to insure perfect safety. Safety catches of tested efficiency and strength must be used in connection with the cages, to hold them in case of accident, and when the cages are lowered the tops of the shafts shall be covered with gratings.

Sec. 13. The filling of shafts shall be done with material of approved quality, which must be carefully lowered, unless otherwise permitted by the engineer, and must be thoroughly compacted by ramming. If no masonry is being built in the shaft the contractor will not be required to lower the material after there is a covering of 10 ft. or more over an arch.

Sec. 16. The contractor shall line the bottom and sides of the tunnel, and build an arch at the top, wherever directed by the engineer. At Shaft No. 1, and for such distance from it as the engineer may deem necessary in order to prevent percolation from the proposed reservoir on the Nashua River, the cross-section of the tunnel may be changed to a circle or such other form as the engineer may designate, and be lined with thicker masonry than is used in other parts of the tunnel. Special care shall be taken to make this portion of the lining water tight. The work of trimming the tunnel to its full size, of lining the sides and of building an arch at the top must progress simultaneously with the work of excavation, so as to keep the masonry as near the heading as it can be kept without danger of injury to it. Unless the portion of the invert adjacent to the sides is built before the side lining, the contractor shall, without compensation therefor, by cutting into the rock, prepare a suitable foundation for the side lining. Everywhere below the level of the point where a radial line inclined at an angle of 45° with a horizontal intersects the exterior of the upper arch, the contractor shall build the masonry solidly to the rock, unless there is timbering which cannot be removed, in which case he shall build solidly to the timbering.

Sec. 17. Where the thickness of the masonry lining does not exceed 20 ins., brick masonry will be used; but where the total thickness at any place is greater than 20 ins., the kind or kinds of masonry to be used will be designated by the engineer.

Sec. 19. The tunnel must at all places be excavated so that no rock or other material will project inside of the line of the cross-section determined by the Engineer for that place. No payment will be made for any excavation outside of the line of the cross-section of the tunnel excavation determined by the Engineer, but all loose or shaky rock must be removed from the top of the tunnel, from the sides in places where they are not to be lined, and from all other parts of the tunnel if the rock has been moved from its original position.

Sec. 23. In rock excavation the drilling and blasting must be conducted with all possible care, so as not to shatter the roof or sides of the tunnel outside of the prescribed lines determined by the Engineer; and if in his opinion the Contractor, by the use of too high explosives, bad location of drill holes, or want of proper skill and attention, shall excavate the tunnel or shafts to unnecessarily large dimensions, the excess of tunnel or shaft area thus formed shall be filled solid with masonry of a quality herein specified, laid in mortar, and the Contractor shall not be entitled to receive any payment therefor.

Sec. 24. The Contractor shall be responsible for properly supporting the roof and sides of the tunnel with timber or other supports. If, however, the Engineer is of opinion that at any point sufficient or proper supports have not been provided, he may order additional supports, or order them modified or replaced at the expense of the Contractor, and the compliance with such orders by the Contactor shall not relieve him from his responsibility for the sufficiency of such supports.

Sec. 25. All timber work is to be removed from the tunnel as the masonry therein advances, except that if, in the opinion of the engineer, any timber work be so located that its removal would endanger the safety of the masonry, it shall be left in, and no payment shall be made to the contractor for such timber.

Sec. 27. The power employed in driving the tunnel, except when otherwise allowed, shall be compressed air, to be applied by the most approved method, or some more effective force, approved by the chief engineer and the board. The contractor shall use such appliances for pumping, drilling, blasting, ventilating, hauling or hoisting materials, and for all other operations connected with the excavation and support of the tunnel and shafts, as will secure the rate of progress herein specified. If at any time before the inception or during the progress of the work such appliances appear to the engineer to be inefficient and inappropriate for securing the said rate of progress or the quality of work required, he may order the contractor to increase their efficiency or to improve their character, and the contractor must conform to such order, but the omission of the engineer to demand such increase or improvement shall not relieve the contractor from his obligation to secure the rate of progress established in this agreement. The contractor shall use electricity for lighting the tunnel, and keep it free enough at all times from smoke and noxious gases to enable the workmen and inspectors to properly and safely perform their duties, and to permit the engineer to establish the alinement of the tunnel and do other engineering work efficiently.

Sec. 28. The bricks shall be the best quality of hard burnt bricks, burnt hard entirely through, and regular and uniform in shape and size. They shall be of compact

texture, and bricks which, after being thoroughly dried and immersed in water for 24 hours, absorb more than 16% in volume of water may be rejected.

Sec. 29. To insure their good quality, all bricks will be subjected to inspection, and if found of improper quality will be condemned, the character of the test to be determined by the engineer. They are to be culled before being taken into the tunnel, all bricks of an improper quality to be laid aside and removed, the engineer to be furnished with competent men for this purpose by and at the expense of the contractor. No bricks are to be taken for use from a pile where the culling is in progress. Bricks to be used in the face work shall have even, straight-edged faces.

Sec. 31. All the cement will be subjected to inspection and rigorous tests, and if found of improper quality will be branded and must be immediately removed from the works; the character of the tests to be determined by the engineer.

Sec. 32. The contractor shall at all times keep in store at the site of the work, a sufficient quantity of the cements to allow ample time for the tests to be made without delay to the work of construction. The engineer shall be notified at once of each delivery of cement. All cement shall be stored in a tight building, and each cask must be raised above the ground by blocking or otherwise.

Sec. 34. Mortar for laying brick and stone masonry shall be prepared from cement and sand of the qualities before specified. The ingredients shall be evenly spread and thoroughly mixed dry, in the following proportions: For American cement mortar used in the brick masonry, 1 part by measure of cement to 1, 1½ or 2 parts of sand, as may be directed by the engineer. For Portland cement mortar used in the brick masonry and for mortar used in the stone masonry, 1 part by measure of cement to 2 parts of sand. A moderate quantity of water is to be afterwards added, to produce a paste of the proper consistancy, the whole to be quickly and thoroughly worked with hoes or other tools. In measuring cement it shall be packed as received from the manufacturer; in measuring sand it shall not be packed more closely than by throwing it into a barrel. Mortar shall be mixed in such quantities as will allow it to be used very soon after being mixed, and any mortar not used three-quarters of an hour after being wet shall be rejected.

Sec. 36. Bricks are to be thoroughly wet just before laying; each brick shall be completely imbedded in mortar under its bottom, on its sides and on its ends at one operation, care being taken to fill every joint. Special means satisfactory to the engineer must be taken to insure the complete filling of the joints at the key of the arch. The work must be well and thoroughly bonded. The bricks shall be laid to a line, with the beds in the line of the radii of the curves, and with as close joints (not exceeding ¼ inch for face work) as may be from time to time directed. Work not laid upon centers shall have the face joints neatly struck or pointed when laid; all work laid upon centers shall have the mortar projecting beyond the faces of the bricks scraped off within one day after the centers are removed, and the joints shall be pointed and left in neat condition. The surface of the rock at the bottom and sides of the excavation is to be thoroughly cleaned by the removal of all stones, dirt, grease, lampblack or other substances so that the mortar will adhere to the rock.

Sec. 37. Until the tunnel excavation is completed, all brick masonry shall be laid between the hours of 6 a. m. and 6 p. m., unless otherwise permitted by the engineer.

Sec. 38. Whenever water enters the tunnel through fissures or crevices, care must be taken that no water shall interfere with the proper laying of the masonry in any of its parts, and the contractor is to build small brick drains, build pipes into the masonry, removing rock if necessary in order to place the drains or pipes outside of the line of the cross-section of the tunnel excavation, and take such other measures as may be necessary to take care of the water, and shall include the cost of such protective work in the price bid for brick masonry. Under no circumstances must masonry other than that forming the sides of the drains be laid in water.

Sec. 42. Concrete masonry shall be formed of sound broken stones or clean gravel stones and sand and American cement of the quality before specified. The stones shall be of varying size; none to be more than 2½ ins., and but very few to be less than ¼ in. in their greatest diameters: They shall be free from clay or other objectionable material and shall be mixed with the sand and cement in the proportion of 5 parts by measure of broken stone or gravel to 2 parts of sand and 1 part of cement.

Sec. 43. The mixing shall be done in a manner satisfactory to the engineer, and after the materials are wet the work must proceed rapidly until the concrete is in place and is so thoroughly rammed that the water flushes to its surface and all of the interstices between the stones are entirely filled with mortar. The concrete shall be laid in layers of such thickness as the engineer may determine. The contractor shall not permit walking over or working upon the concrete until it has set for a sufficient time, to be determined by the engineer.

Sec. 45. Wherever directed by the engineer the contractor shall fill with grout, or with stones and grout, the cavities behind the timbering or masonry, and for this purpose he shall furnish men, implements and materials required for drilling or cutting holes, for placing the stones, and for injecting the grout. This work shall be done by methods and in a manner approved by the engineer, and the contractor shall receive as full payment for its satisfactory performance its reasonable cost to him, as determined by the engineer, plus 15% of such cost, but no payment shall be made for any drilling or grouting required to make good defective work.

Sec. 46. The engineer may drill into or cut open the masonry lining of the tunnel, and for this purpose the contractor shall furnish all necessary tools and labor. If the work so examined is found to be defective in any respect, it shall at once be remedied by taking down and rebuilding the defective work, or in such manner as the engineer may direct, and the contractor shall receive no compensation thereof; but if defects are not found, there shall be paid for the examination and reconstruction their reasonable cost, as determined by the engineer, plus 15% of such cost.

Art. XI. The contractor in the construction of these works shall give preference in employment to citizens of the Commonwealth, and persons employed in the performance of manual labor under this contract shall not be required to work more than nine hours in each day, and said nine hours shall constitute a day's work.

A NEW STEAMSHIP COALING SYSTEM.

We illustrate herewith a novel arrangement for coaling steamships which is now in use at Mobile, Ala. The machinery was designed and installed by the Link Belt Machinery Co., of Chicago and New Orleans, for the Mobile Coal Co.

The barge shown is a Norwegian bark which was dismantled and cut down to the deck line. A flat bottom barge or a sea-going boat provided with a keelson would have suited the purpose as well. The hold of the barge is floored in the shape of a long hopper which discharges into a conveyor placed underneath it, running horizontally the entire length of the boat. This conveyor in turn discharges the coal into the inclined conveyor seen in the cut, which has a height of 35 to 40 ft.

STEAMSHIP COALING BARGE AT MOBILE, ALA. MACHINERY BUILT BY THE LINK BELT MACHINERY CO., CHICAGO.

above the deck line, and which delivers the coal through a swinging and telescoping spout directly into the bunkers of the ship to be coaled. These bunkers are generally accessible through hatches, consequently but little inconvenience or dirt is occasioned while the ship is being coaled.

A double-strand of steel chain is used, the chain being connected by crossbars to which are attached the large flights that carry the coal. The capacity of the conveyors is 80 to 90 tons of "run of mine" coal per hour. Power is furnished from a 20 HP. horizontal engine. The loading and discharging of cargoes is, of course, not interfered with and if convenient a steamer may be out in the stream while coaling. Ordinary steamers calling at Mobile carry from 160 to 300 tons of coal. For operating the conveyors, one engineer and two helpers to control the gates and spouts are all the force required.

The ordinary methods used at Mobile which this barge supplanted require a coal barge to be pulled up alongside the ship to be coaled and inclines to be built, up which the coal is wheeled. It takes about 18 laborers 18 hours to wheel 200 tons of coal into the ship.

EFFECT OF THE FINENESS OF SAND UPON THE STRENGTH OF CEMENT MORTAR.

Some interesting experiments to determine the comparative strengths of cement mortars made with coarse and find sand are recorded in the November "Journal of the Franklin Institute" by Mr. A. S. Cooper, U. S. Assistant Engineer, Savannah, Ga. These experiments were made to confirm a much less extensive set of tests published in the Engineering News of Jan. 3, 1895, and which showed results so opposite to those of previous experimenters that their accuracy was questioned by the editor. These preliminary experiments indicated that fine sand is better than coarse sand for cement mortar. The later and more extensive experiments proved the results of the preliminary tests to have been erroneous, and agreed in a general way with those of all former experimenters. The conditions and results of Mr. Cooper's later tests are briefly abstracted in the following paragraphs:—

Method of Making Tests.—The sand was graded by means of 13 sieves ranging from 8 wires to 140 wires to the lineal inch, the grades being indicated by the two sieves used. The grade 8-12 for example, meaning a sand which would pass an 8-mesh and be held by a 12-mesh sieve. The diagram shows the different sieves used.

The mortar was mixed rather dry, about the consistency of moist snow. In mixing, the sand and cement were first weighed and then mixed dry by placing them in a cubical box and revolving it. The apparatus was a cubical concrete mixer in miniature. The water was measured and mixed into the cement and sand on a stone table, using a trowel. Generally enough mortar was made at one mixing for eight briquettes. The briquettes were molded in

brass molds of the American Society of Civil Engineers' recommended form, but were pressed into the molds by the press designed by Prof. Chas. D. Jameson, State University of Iowa (Eng. News, Feb. 7, 1891.). Some irregularity of pressure resulted from this machine, but tests made to show the effect of this irregularity lead to the conclusion that it was not as great as that of good hand molding and in fact cut but little figure in the general results of the tests. As soon as taken from the press the briquettes were placed on a stone slab and covered with a wet cloth for 24 hours and then immersed in water. Four of the eight briquettes were tested when seven days old and four when 56 days old.

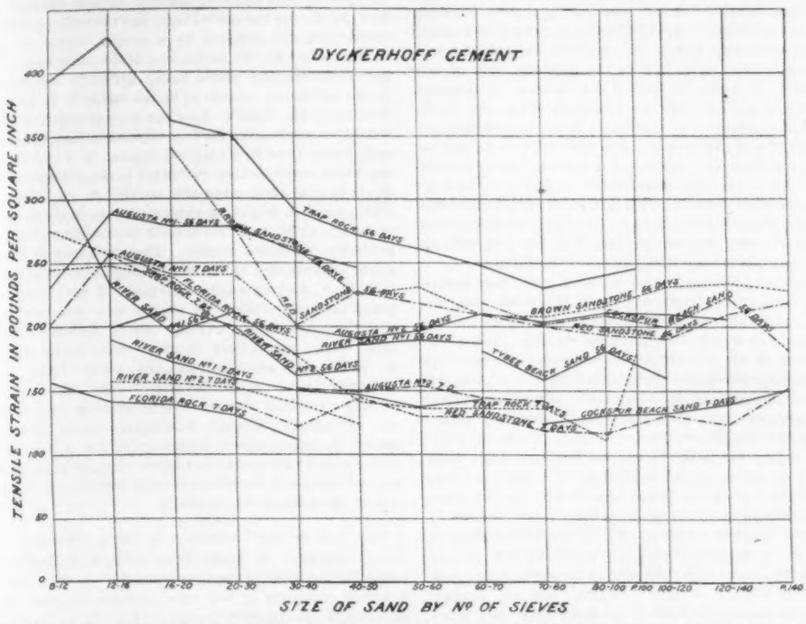

DIAGRAM SHOWING EFFECT OF FINENESS OF SAND UPON STRENGTH OF DYCKERHOFF PORTLAND CEMENT MORTAR.

Kinds of Sands.—The sand used consisted of several varieties so selected as to give a wide variation in this respect as well as in respect to fineness. The author describes these sands as follows:—

River Sand.—This sand was taken from the bed of the Savannah River. It was of a light yellow color, quite clean, and was composed of a mixture of sharp and well rounded grains. The coarse grades seemed to have a greater percentage of rounded grains than did the fine grades.

Beach Sand.—The beach sands were much cleaner and whiter than the river sands, and except for a few black particles were pure white. They had apparently fewer rounded grains than did the river sands. The grade that passed the 140 sieve was just as sharp and free from dust as the coarser grades.

Tybee Bar.—This sand was taken from the outer bar at Tybee, Ga., and was practically identical with the beach sand except that it contained more black particles and a little larger percentage of the very fine grades.

Cumberland Quicksand.—Under the microscope this sand looked about the same as beach sand, but a little whiter and clearer and having more black grains in the lowest grade. The grading showed it to be a little coarser, but no difference was noticed as to sharpness. When wet it feels grating to the touch.

Warsaw Quicksand.—This sand and also the St. John's quicksand have all the characteristics of the Cumberland quicksand.

Augusta No. 1.—This sand was taken from a pit in the Savannah River valley, near Augusta, Ga., and is very similar to river sand except that it has fewer rounded grains.

Augusta No. 2.—This sand was taken from the same pit as No. 1, and was practically identical to the beach sand in every particular, except the color which was yellow instead of white.

Red Sandstone.—This sand was obtained by pulverizing red sandstone. The grains had rounded edges and were oblong in shape. Size 20-30 was not made up of individual grains but of small grains cemented together and hence had a very rugged surface. The size that passed a 140 sieve was mostly dust. A sand from crushed brown sandstone was similar to the red sandstone sand.

Florida Rock.—This sand was obtained by breaking a flinty limestone from Florida. It was light and had sharp edges and very smooth surfaces.

Trap Rock.—This sand was from a very black and dense variety of trap rock extremely hard to break. The surfaces of each grain were very rough.

Granite.—This sand came from a fine-grained grey granite which broke similar to the trap rock.

Results of Tests.—The accompanying diagram shows the results obtained with the Dyckerhoff Portland cement. Tests were made with other cements, both Portland and natural, but the general features brought out were no different.

Generally speaking, the coarser the sand the stronger the mortar made from it, but the differences between the grades below 20-30 were so slight that so far as the sizes are concerned they may be considered as one class. There seemed to be a tendency toward an increase in strength with grades finer than 100-120, but so few samples of these grades were obtained that this increase may be considered accidental. There is an unmistakable indication of weakness in the 8-12 grade, for in the detailed tables about two cases in three give the 12-16 mortar as stronger than the 8-12 mortar. The shape and condition of surface of the grains has much to do with the strength. The Florida stone which broke up into the sharpest sand of all did not give so strong a mortar as did some of the natural sands, probably on account of the smooth surface of the grains. Trap rock sand was not as sharp as Florida rock, but gave much better results, owing to the very rough surfaces of the grains. The comparison of the beach and river sand has shown the latter to be the better for cement mortar by from 2% to 10%. After the grade of 40-50 was reached in the river sands there seemed to be no practical difference between it and the beach sand.

From the tests as a whole the following conclusions may be drawn: (1) Other things being equal, coarse sands are better than fine sands for cement mortar up to the grade of 12-16, or about 1-12 in. in diameter. (2) Below the grade of 40-50, or about 1-60 in. in diameter, there is no practical difference in the value of the different sands as far as size is concerned. (3) The shape and condition of the surfaces of the grains have as much to do with their value for mortar as the size.

The Krag-Jorgensen small arm, recently adopted for the U. S. Army, seems to have aroused considerable opposition among officers and enlisted men. Some condemn it altogether and say the calliber is too small and the gun inaccurate at ranges over 300 yds. Complaint is made that parts of the gun are made of metal that is too soft, and wears too rapidly, and that gas escapes from the breech mechanism. There seems to be considerable prejudice in some of these opinions, and one of the chief objections apparently is that it is not a target-gun, and no good records can be made with it by the sharpshooters. But all practically admit that with proper powder it vastly increases the danger zone, and that it is a deadly war weapon, that has not, as yet, had a fair trial. But it is also evident that there is sufficient ground for objections to cause the design and the manufacture of the gun to be carefully overhauled before turning it out in further quantity.

WEATHER TABLE FOR DECEMBER, 1895.

(Furnished to Engineering News by the Department of Agriculture.)

Stations.	(Deg. Fahr.) Temperature.				Wind.			Precipitation—Rain or melted snow. Inches.		
	Average.	Maximum.	Minimum.	Range.	Velocity in miles per hour		Direction at time of max. velocity.	Total.	Heaviest in 24 hrs.	Number of rainy days.
					Ave.	Max.				
NORTHERN CITIES.										
Northfield, Vt.	24.4	61	−13	74	9.2	49	SW	4 75	1.71	13
Portland, Me.	30.1	59	− 1	60	8.7	49	SE	3 39	1.34	8
New York City	36.9	58	13	45	16.2	73	W	1.87	1.09	7
Pittsburg, Pa.	37.4	67	13	54	17.2	31	SW	3.29	1.04	13
Chicago, Ill.	29.6	56	Zero	56	18.8	54	NE	6.76	2.06	15
Omaha, Neb.	29.4	58	− 2	56	8.1	28	SE	0.16	0.14	3
St. Paul, Minn.	21.1	44	− 4	48	7.8	35	W	0.38	0.21	5
Duluth, Minn.	19.8	40	− 7	47	9.9	46	NW	0.71	0 44	9
Bismarck, N. Dak.	18.3	48	−18	66	10.2	38	NW	0.27	0.12	5
Average	27.4	55	− 2	56	10.7	45	.....	2.38	0.97	9
SOUTHERN CITIES.										
Washington, D. C.	38.8	66	13	53	7.0	42	SW	2.38	1.10	9
Louisville, Ky.	39.0	66	12	54	9.2	32	NW	5.31	2.38	14
St. Louis, Mo.	37.0	61	7	54	12.4	37	S	4.66	1 71	12
Savannah, Ga.	51.0	74	26	48	7.9	36	W	1.71	0.86	8
Kansas City, Mo.	32.6	63	6	57	9.8	37	NW	5.12	1.83	10
Jacksonville, Fla.	53.5	80	28	52	6.7	37	SW	1.18	0.69	7
Chattanooga, Tenn.	42.6	66	15	51	8.4	47	W	3 11	0.85	10
New Orleans, La.	53.8	75	34	41	10.5	28	SE	4.52	1.55	11
Memphis, Tenn.	41.4	69	20	49	12.5	42	W	3.09	1.38	13
Palestine, Tex.	50.2	73	24	49	8.7	29	W	4.34	2.13	7
Average	41.3	69	18	51	9.3	38	.....	3.54	1.47	10
WESTERN CITIES.										
Helena, Mont.	23.6	51	− 4	55	8.8	44	SW	1.12	0.39	7
Port Angeles, Wash.	40.3	64	22	42	6.7	37	W	7 95	1.59	23
San Francisco, Cal.	48.6	60	39	21	7.3	34	S	4.43	0.34	9
Salt Lake City, Utah	20.4	46	2	44	5.1	44	N	0.80	0.19	11
Santa Fe, N. Mex.	25.9	52	− 2	54	7.3	27	NE	1.09	0.45	8
Denver, Colo.	31.0	69	5	64	9.8	60	NW	0.01	0.01	1
Yuma, Ariz.	51.0	80	20	60	7.3	45	NE	0.00	0.00	0
Average	30.1	60	12	47	7.5	42	.....	2.21	0.42	8

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AND
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A great deal is being said just now concerning the error of 15,000,000 gallons which was made in computing the capacity of the Newark water-supply conduit of the East Jersey Water Co., and from a hundred sources we hear it said that this is a sample of the inaccuracy and unreliability of engineering work. This journal, on behalf of the engineering profession, desires to emphatically assert that all such wholesale indictments of the profession are unjust and unwarranted. If a noted lawyer makes an error in rendering an opinion, no one thinks of declaring the whole legal profession incompetent; if an experienced surgeon makes a wrong cut in a critical case, no one thinks of declaring modern surgery a farce. Is it not plain that it is equally unjust and unfair to question the accuracy and reliability of all engineering work because of one such notable error?

In our issue of Dec. 19 we published an official report by the Chief Engineer of the East Jersey Water Co., in which he set forth the process through which the error in the computation occured, the statement being, in effect, that reliance was placed on gagings of the old Rochester riveted conduit made 14 years previously, and checked only by the formulas of Hamilton Smith. In another column of the present issue Mr. Rudolph Hering shows that other experiments were available when the Newark conduit was designed, which should have been quite sufficient to have thrown doubt on the Rochester gagings and to have led to a determination of the conduit capacity with a much less error than 30 per cent.

We believe Mr. Hering does a valuable service to the profession in thus presenting these facts, and that it cannot be too strongly or explicitly laid down that the work of engineers as a class is neither inexact nor unreliable, despite such isolated instances as may occur.

We cannot let this unfortunate error pass without calling attention to another aspect of it, and that is the need of greater care on the part of many engineers in the study of professional literature bearing upon any problem which may come before them. We hear it sometimes said that engineers cannot afford the money to pay for engineering journals, and more commonly, that they have not the time to spare to read them. We could cite not one but many instances which would present undoubted proof that engineers cannot afford to do without the best journals devoted to their profession, nor can they afford to neglect to read them. "In a multitude of counsellors there is safety," runs the proverb. Through the literature of the profession, the young engineer, or the old one for that matter, avails himself of the experience of hundreds of fellow-members of his profession, experience which he could not collect individually even with unlimited expenditure of time and money.

A large electric lighting company, operating several stations in the heart of a closely built-up city, has found itself obliged to purchase the property adjoining and in the rear of its stations, and even in some cases that on the opposite side of the street, in order to avoid the defence of damage suits on account of the vibration from the high-speed engines in its stations. It has expended, we understand, little short of a half-million dollars in the purchase of property of this class, which it finds for the most part unrentable at anything like remunerative figures. We do not know whether the experience of this company has been paralleled by that of other companies; but if it has not been in the past, it is very likely to be in the future.

This experience seems to us a most instructive one from several points of view. It is a fine example, for one thing, of how unforeseen contingencies will come in to wreck the fortunes or pare down the profits of an enterprise in a manner which its original promoters never counted on. It is also an unusually good example of the need of making radical departures from long-established practice whenever new conditions demand them. Up to the present time, we believe, engine builders have paid little attention to the reduction of vibration. The balancing of the ordinary stationary engine, even when designed to run at very high speed, is done in a crude manner, so far as our information extends. If there is any builder of high-speed engines who is an exception to this rule and who figures out the counter-balance weight required for an engine with the same care that it is computed for a locomotive, we shall be very glad to hear from him.

Builders of high-speed engines, in fact, have merely followed the precedents set by the older builders of Corliss and other slow-speed, long-stroke engines. They secure their engines to a heavy masonry foundation and rely on the mass of this to absorb the forces which are imparted to it at each stroke of the engine. This plan was effective in the case of the slow-speed engines. Experience shows that it is not effective in the case of high-speed engines. It is altogether likely that the experience of the electric lighting company referred to above will be repeated in other cities. In other words, there is already a demand for a steam engine which shall be self-contained, or which shall not give a powerful kick to its foundation at every stroke, as every engine now in the market does. And the demand, be it noted, is quite certain to increase in the future.

As evidence that this demand for a self-contained steam motor is an actual and tangible fact, with dollars and cents to back it, it may be said that the company referred to is now beginning experiments with steam turbines, and is prepared to adopt them, even at a greater first cost per horse-power, or a less economical consumption of steam, if it shall prove, as will doubtless be the case, that they will remedy the troubles from vibration. Are American builders of steam engines prepared to meet the competition of the steam turbine? Is it not worth while for them to take up seriously the problem of either balancing their present engines in a rational and scientific manner, or breaking away from long-established lines and building self-contained engines?

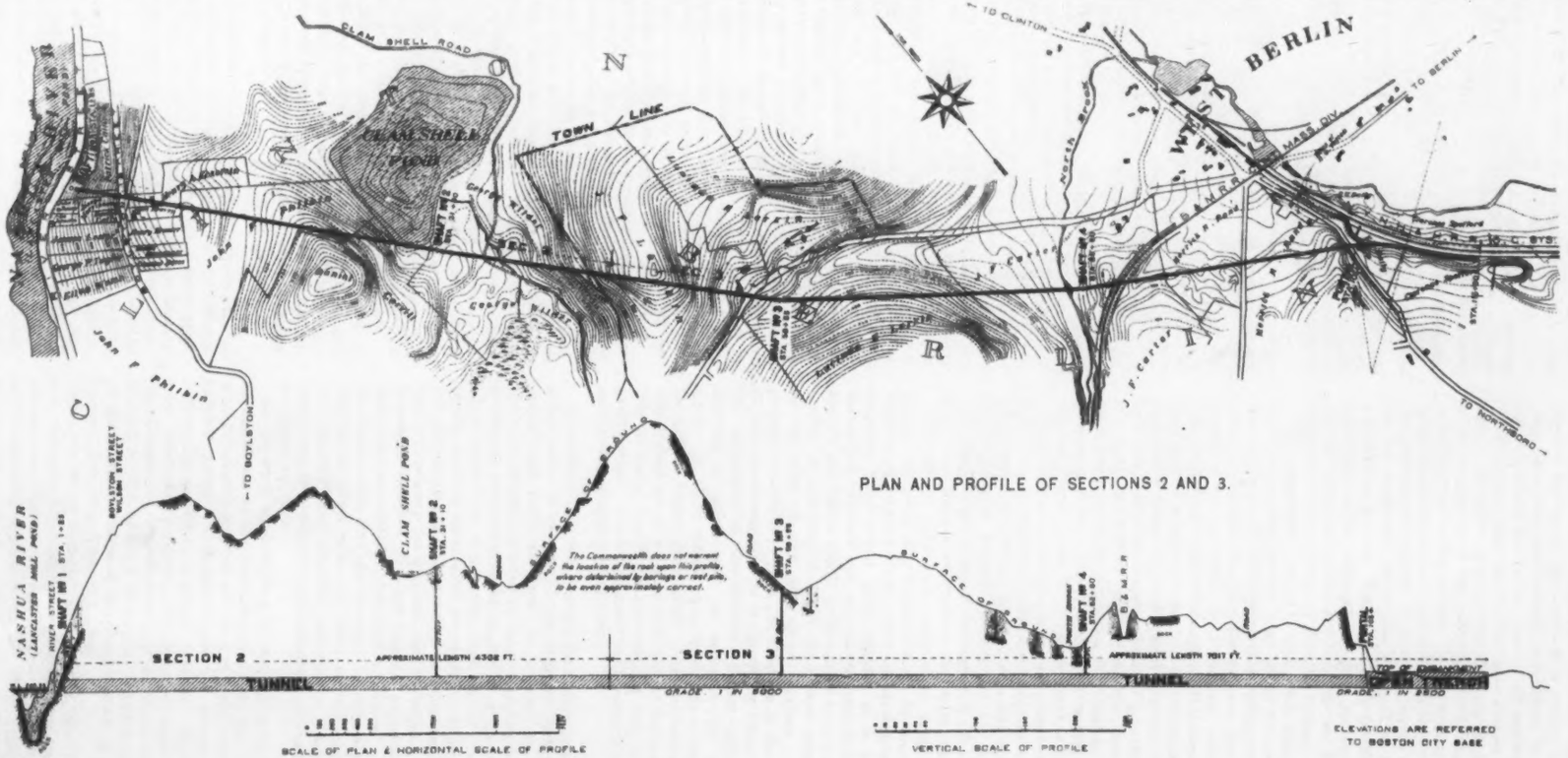
By the work already done in the scientific balancing of marine and locomotive engines, the path is pretty plainly marked out for any builder of stationary engines who desires to take the trouble to balance his engines in a proper manner. We may refer interested readers to Mr. Yarrow's paper on the balancing of torpedo-boat engines in our issue of April 28, 1892, or Mr. Parke's most valuable paper on the general problem of balancing engines in our issues of Feb. 22 and March 1, 1894.

As some of our readers may remember, Mr. Yarrow balances his high-speed marine engines by placing eccentrics on the shaft which give a vertical reciprocating motion to certain "bob weights" that exactly counterbalance the action of the reciprocating parts of the engine. There seems to be no reason why his system could not be applied to vertical electric lighting engines. For horizontal engines, the principle of the Wells' balanced engine, originally exhibited, we believe, at the Centennial Exposition, might be used. In recent forms of this engine, a low pressure cylinder is placed behind the high-pressure cylinder. The former has two piston rods and two connecting rods coupled to two cranks for the main shaft; and the latter a single connecting rod, coupled to a center crank on the shaft, placed at 180° to the line of the other two. All the reciprocating parts being properly weighted, those belonging to one cylinder balance those belonging to the others. Another type of engine which would no doubt give far less vibration than the common form is the Brotherhood engine, in which there are three single-acting cylinders arranged around a circle so that their axes are at 120° to each other. This principle might be extended so as to make four cylinders at 90° and this should make practically a perfectly balanced engine. The tendency of electrical engineering to the use of large units of power, 1,000 H. P. and upwards, will make it necessary for many engine builders to design new patterns for their engines in any event. While they are about this work we believe it will well repay them to make an attempt to get away from the ordinary ruts and develop some new style of self-contained engine which shall be free from all vibration. Engine purchasers could always afford to pay a much higher price for a machine which required foundation only to support its weight, and which could be set up in any building without risk of shaking down its walls.

The "refuge bay" question is being discussed in San Francisco, in connection with a proposition made by the wife of Congressman Joy to erect such a safety platform at her own expense between the car tracks on Market street. This is a street crowded with cars and vehicles of all kinds and it is proposed to erect the refuge at a particularly dangerous crossing point. The form of platform proposed is practically identical with those existing on the Strand, in London, and in the streets of some Continental cities. It is simply a narrow, raised platform, with a lamp post in the middle and four iron posts at the ends; and its purpose is to serve as a mid-street refuge in crossing streets where the traffic is dense. The teamsters of San Francisco, however, loudly protest against the innovation, as likely to prove a serious obstruction at that point, and the "Chronicle" fears that their protests will have more weight than the wishes of "timid women and children."

There are streets in New York, and probably in other large cities, where these refuges would be an acceptable boon to stout men as well as to "timid women," and it is somewhat strange that they have never been introduced into this country. At points on down-town Broadway they would be particularly useful; and would probably have been put in before this had it not been for the closeness of the street car tracks forbidding a proper location without change in these tracks. As to interfering with the traffic of teams and cabs these refuges actually facilitate the movement of vehicle traffic by tending to keep the lines of up and down travel separate. They compel drivers to keep to their own side of the street and prevent the tangle and delay common in unrestricted driving. It is to be hoped that Mrs. Joy will succeed in her object lesson and make the advantages of a properly built refuge bay so apparent that other American cities may adopt what is already regarded as a necessity rather than a convenience in London and in cities of Europe. With the introduction of the trolley, some such safeguard in crossing streets is more than ever demanded; and its use in Brooklyn and other cities whose record of trolley accidents has been frightfully large might have saved many lives.

An instance of how an item of interest will continue going the "rounds of the press" has come to our notice in an article on "The Influence of Vibration on Steel," reprinted by "The Engineer," of London, in its issue of Dec. 13, 1895, from the "Railroad Gazette." It states that "recent investigation by Mr. Wm. Metcalf appear to show that popular opinion is wrong and that the hard steels suffer less from vibration than soft steels." Then follows an account of the experiments made by Mr. Metcalf

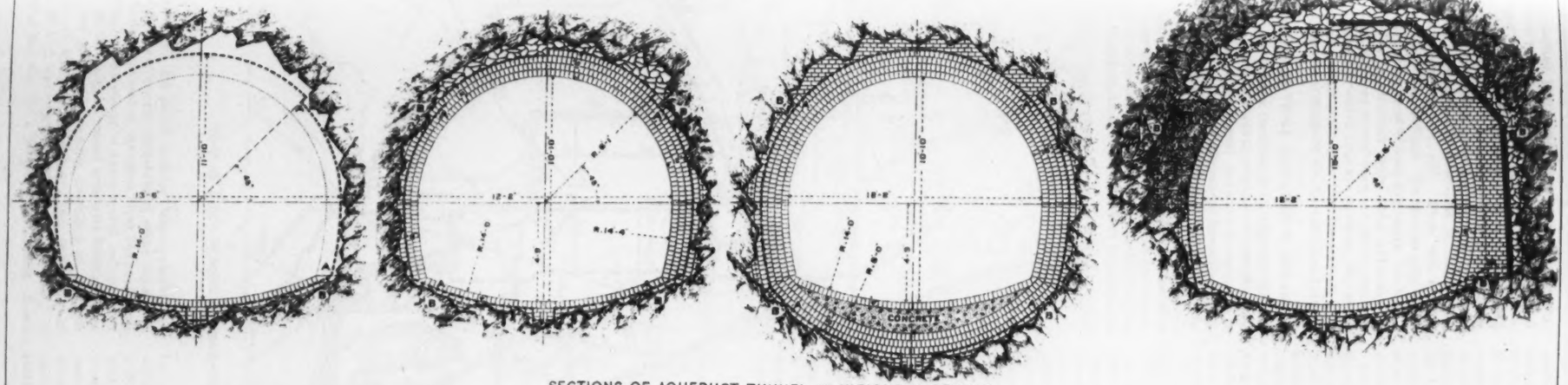


PLAN AND PROFILE OF SECTIONS 2 AND 3.

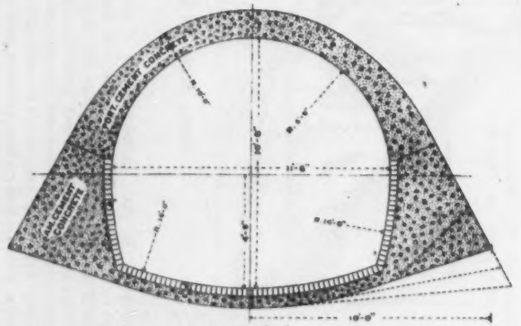
Suggested Plans for Large and Small Shafts.

Longitudinal Section through Drain,
Showing Method of Diverting Water into Invert.

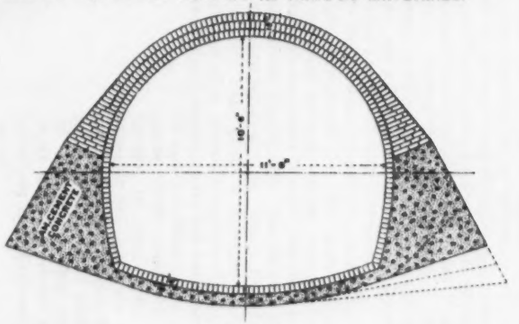
VARIOUS METHODS OF COMPLETING SHAFTS.



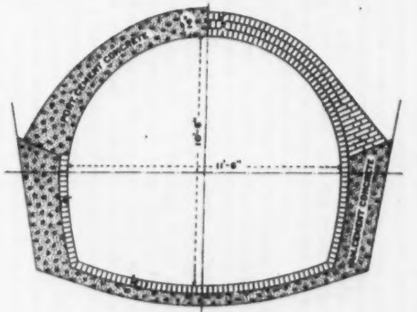
SECTIONS OF AQUEDUCT TUNNEL IN VARIOUS MATERIALS.



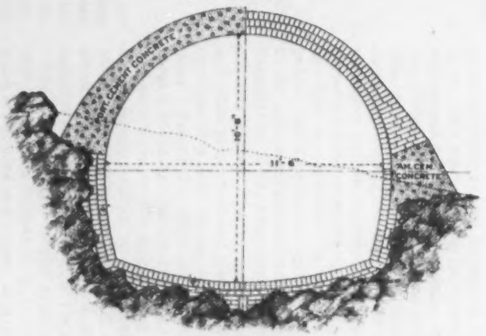
Concrete Arch.



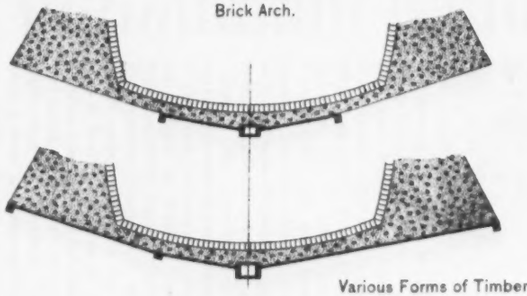
Brick Arch.



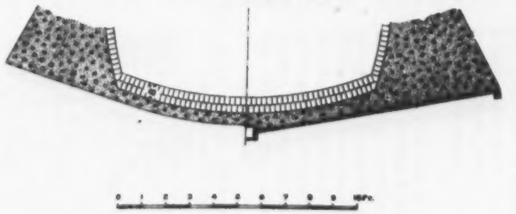
In Compact Earth.



In Rock.



Various Forms of Timber Foundations and Drains.



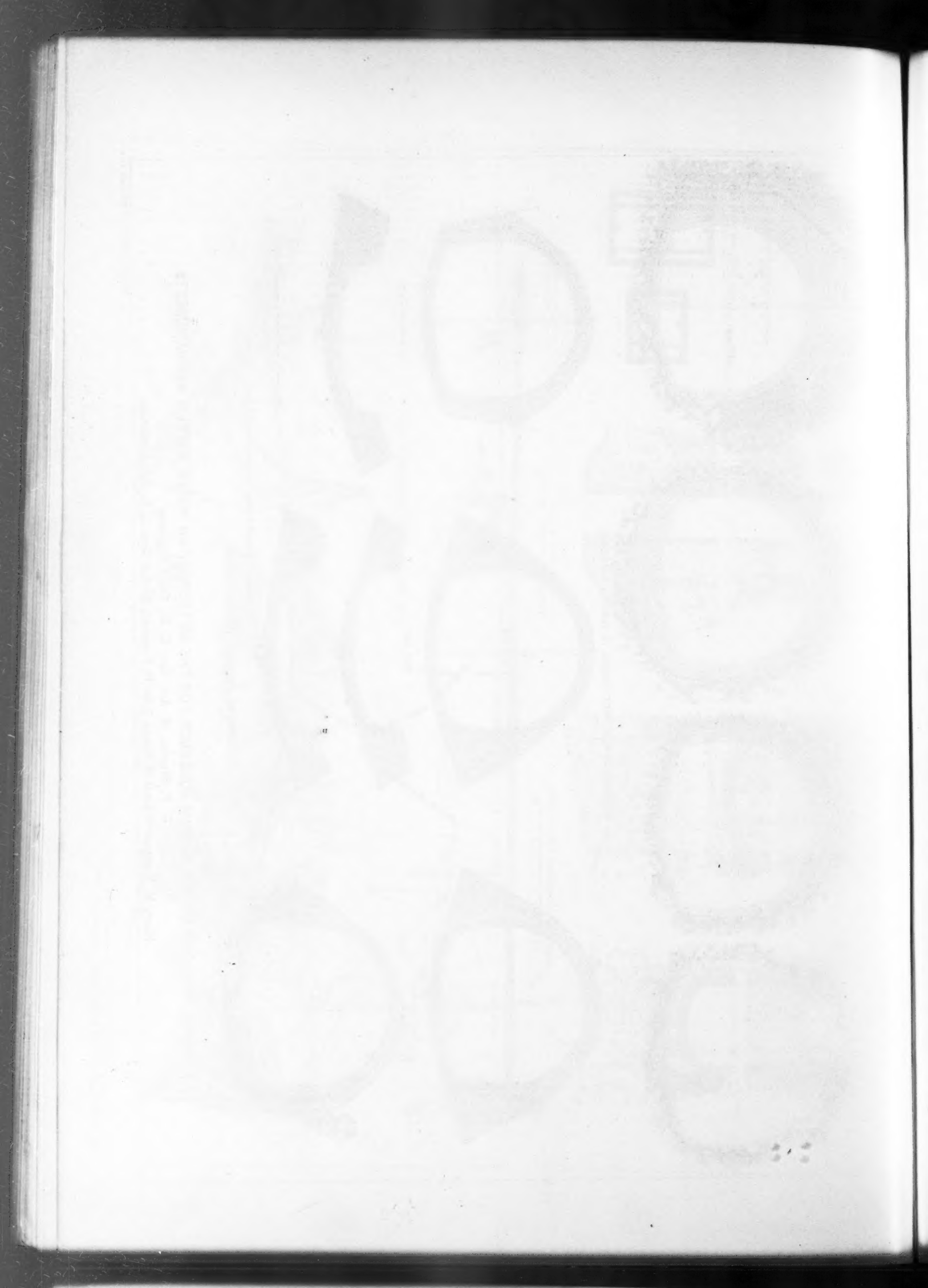
SECTIONS OF AQUEDUCT IN OPEN TRENCH.

TUNNEL SECTIONS OF THE NASHUA AQUEDUCT FOR THE METROPOLITAN WATER SUPPLY, MASSACHUSETTS.

F. P. Stearns, M. Am. Soc. C. E., Chief Engineer.

Henry H. Sprague, Wilmot R. Evans, John R. Freeman, M. Am. Soc. C. E., Commissioners.

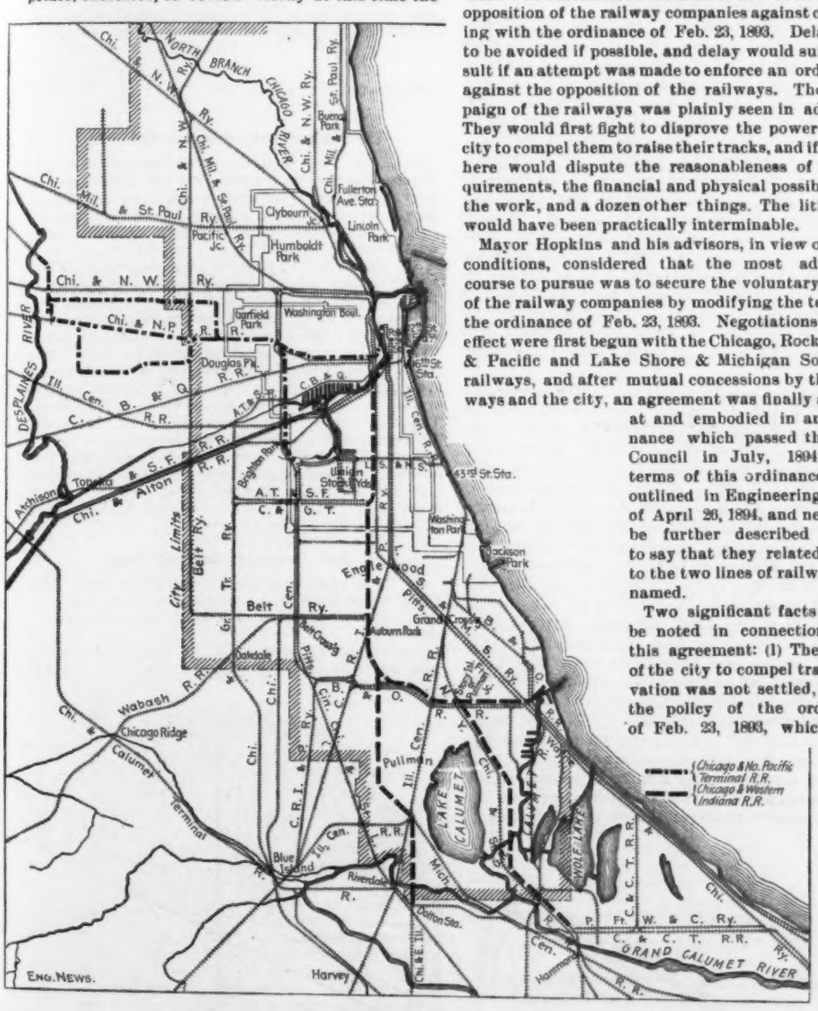
CHAS. HART & SONS, LITH., 39 VESEY ST., N. Y.



which showed that connecting rods for a special machine, running 1,200 revolutions per minute, had a longer endurance the higher the carbon in the rods, up to 0.96 C., the highest tested, which lasted about four times as long as rods of 0.30 carbon. How "recent" the investigations are is shown by the fact that they were originally published in the "Metallurgical Review" in Dec., 1877. They will also be found in the "Transactions," for the year 1879, of the American Institute of Mining Engineers, Vol. VIII., p. 78. The experiments were thus published 18 years ago, but they do not seem to have obtained the attention to which they are entitled. We know of no experiments made since that time which tend to either prove or disprove Mr. Metcalf's conclusions.

PROGRESS OF TRACK ELEVATION IN CHICAGO.

The work of track elevation in Chicago has recently assumed a new impetus through the favorable action of a number of prominent railways in response to the demands of the city officials for immediate progress. Probably it is not too much to say that the prospects for a general movement toward track elevation have never been more favorable than they are to-day since the passage of the first ordinance, nearly three years ago. It seems especially appropriate, therefore, to review briefly at this time the progress of this much needed improvement, although it requires the threshing of some old straw.



MAP OF CHICAGO SHOWING RAILWAY TERMINAL LINES.

The development of the track elevation sentiment leading to the passage of the general ordinance of Feb. 23, 1893, may be passed over with brief mention as it has already been fully described in previous issues of Engineering News. The ordinance of Feb. 23, 1893, was very sweeping in its character. It divided the city into three districts (Eng. News March 9, 1893), and specified that the work of elevation should begin in the first district, comprising the business section of the city, by July 1, 1893, and be completed throughout the city by Jan. 1, 1899. The tracks were required to be elevated 16 ft. above the streets in the clear and the railways were made to bear all land damages. This ordinance contemplated an ideal plan of track elevation from the city's point of view but it met with the united opposition of all the railway companies, and as the sequel has shown this opposition was effective.

The progress of the World's Columbian Exposition during 1893, and the extra duties devolving upon the city officials and the people in connection with that exhibition diverted attention from the more prosaic subject of track elevation, and nothing was done during that summer. At the end of the exhibition and upon the nomination of Mr. John P. Hopkins to succeed Mr. Carter Harrison as Mayor, however, attention was again turned to the matter, and Mr. Hopkins was elected to office on the pledge that he would abolish grade crossings.

The conditions which confronted Mayor Hopkins and his counsel when they took up the work were difficult. On the one hand the people were clamoring for immediate track elevation, and on the other hand was encountered the almost unbroken front of opposition of the railway companies against complying with the ordinance of Feb. 23, 1893. Delay was to be avoided if possible, and delay would surely result if an attempt was made to enforce an ordinance against the opposition of the railways. The campaign of the railways was plainly seen in advance. They would first fight to disprove the power of the city to compel them to raise their tracks, and if beaten here would dispute the reasonableness of the requirements, the financial and physical possibility of the work, and a dozen other things. The litigation would have been practically interminable.

Mayor Hopkins and his advisors, in view of these conditions, considered that the most advisable course to pursue was to secure the voluntary action of the railway companies by modifying the terms of the ordinance of Feb. 23, 1893. Negotiations to this effect were first begun with the Chicago, Rock Island & Pacific and Lake Shore & Michigan Southern railways, and after mutual concessions by the railways and the city, an agreement was finally arrived at and embodied in an ordinance which passed the City Council in July, 1894. The terms of this ordinance were outlined in Engineering News of April 26, 1894, and need not be further described except to say that they related alone to the two lines of railway just named.

Two significant facts are to be noted in connection with this agreement: (1) The power of the city to compel track elevation was not settled, and (2) the policy of the ordinance of Feb. 23, 1893, which was to have a single general plan of elevation for all lines, was abandoned for the policy of dealing with each line separately. The proposed ideal plan of track elevation was abandoned. This individual treatment of each line aroused some objection from those who favored the original plan, but the opposition was not very active, and shortly after the agreement with the Rock Island and Lake Shore companies had been ratified, similar negotiations were completed for the elevation of 1.7 miles of the Galena Division of the Chicago & Northwestern Ry. Negotiations were begun with other companies along similar lines, but nothing had been definitely accomplished, when in the spring of 1895 the administration changed and Hon. Geo. B. Swift became Mayor.

Mayor Swift was in position to do nothing until the winter of 1895, when the matter was taken up again and has been quite vigorously pushed up to this time. To enable a clear understanding of the difficulties encountered by Mayor Swift, a brief study of the railway lines to be elevated is necessary. The accompanying sketch map and table give the main particulars relating to the number of lines entering the city and the route by which the terminal stations are reached.

Table showing railways entering Chicago and manner in which entrance is made:

Railway.	Enters city via—
Atch., Top. & Santa Fe.	Its own line.
Baltimore & Ohio	Chic. & No'n Pac.
Chic., Bur. & Quincy	Its own line.
Chic. & Great W'n	Chic. & No'n Pac.
Chic., Mil. & St. P.	Its own line.
Chic., Rock Isl. & Pac.	Its own line.
Chicago & Alton	Its own line.
Chic. & E'n Ill.	Chic. & W'n Ind.
Chicago & Erie	Chic. & W'n Ind.
Chic. & Grand Trunk	Chic. & W'n Ind.
Chic. & No'n Pac.	Its own line.
Chic. & No'w'n	Its own line.
Chic & W'n Ind	Its own line.
Chich. & W. Mich.	Illinois Central.
Illinois Central	Its own line.
L'k Sh. & Mich. Sou.	Its own line.
L., N., Alb. & Chic.	Chic. & W'n Ind.
Mich. Cent.	Illinois Central.
N. Y., Chic. & St. L.	L'k Sh. & Mich. Sou.
Pitts., Cin., Chic. & St. L.	Its own line.
Pitts., Ft. W. & Chic.	Its own line.
Wabash	Chic. & W'n Ind.
Wisconsin Central	Chic. & No'n Pac.

A computation from the table shows that 17 of these lines enter from the southeast, south and southwest, and six from the west and north. Of the 17 roads entering from the south, 7 enter over their own track and 10 over the tracks of the 7 independent lines. Of the 6 roads from the west and north 4 enter over their own tracks and 2 over leased tracks. Therefore the elevation of 11 rights of way at the highest calculation will give 23 roads elevated entrances into the city.

Taking the 7 roads from the south which enter the city over leased tracks it will be seen that 5 of the 7 run over one road, viz., the terminal line of the Chicago & Western Indiana R. R. For this reason, and also because the tracks of the Pittsburg, Ft. Wayne & Chicago R. R. cannot be elevated except in conjunction with the elevation of the Chicago & Western Indiana R. R., the importance of securing the action of the last-named company was very great. No sooner, however, had Mayor Swift approached the Chicago & Western Indiana officials with a view to securing track elevation than he encountered opposition. Indeed, the same opposition had balked the movements of Mayor Hopkins and the administration preceding.

Before proceeding to the discussion of the reasons for this opposition, attention should be turned to another road which in the latter part of 1894 blocked the elevation of these southern lines to nearly as great an extent as the Chicago & Western Indiana R. R. This road was the St. Charles Air Line. As will be seen from the map, this line branches off from the Illinois Central R. R., and runs directly west just north of Sixteenth St., crossing nearly all the railways entering the city from the south; and its elevation had to be done in conjunction with the elevation of the intersecting lines. The St. Charles Air Line is controlled by several separate companies, and it seemed impossible to get them to come to any agreement regarding track elevation between themselves. Just what proportion of this lack of co-oporation was due to real difference of opinion and what proportion was merely a process of securing delay it is hard to say, but the result was the same. Finally the efforts of the city brought the owners of the St. Charles Air Line to agree to elevation as soon as the intersecting railways would act conjointly with it. At the end of 1894, therefore, the Chicago & Western Indiana R. R. held the position of blocking the elevation of nearly all the railways entering the city from the south.

The reason for the special opposition of the Chicago & Western Indiana R. R. Co. to elevating its track is not hard to explain. It is, in the first place, simply a terminal line, and derives all its revenue from the rental of trackage rights. The tenant

companies pay a certain rental for trackage between the points where they intersect with the terminal line and the station at Polk St., and this rental is a certain percentage of the cost of the Chicago & Western Indiana R. R., proportioned on the number of cars used by each tenant company. None of the tenants hold by a perpetual lease; indeed, some of the leases expire in a few years. To raise the rental of the companies with long leases in order to get money for track elevation was a hard thing to accomplish on the one hand, and on the other hand to get the companies with short leases to assume a bond issue pro rata to their rental was still more difficult, for after they had borne part of the expense of elevation it was entirely possible that their rental would be raised to an exorbitant degree in a few years. These financial complications were not impossible of solution, but their solution was difficult enough to make the Chicago & Western Indiana R. R. Co. reluctant to take up the question of track elevation as long as it could be avoided. As a consequence that company fought for delay by pleading the impossibility of getting an agreement between the tenant companies as to the method of paying for the work.

Mayor Swift opened his campaign for track elevation in the autumn of 1895 by causing the passage of an ordinance requiring all trains to stop at each side of the Sixteenth and Clark St. crossing and not proceed until given permission by a flagman. The significance of this ordinance will be understood when it is explained that the four tracks of the Chicago & Western Indiana R. R. cross at grade at this point, and therefore every train of its five tenant companies was brought to a full stop on each side of the crossing. The ordinance was a serious annoyance to these companies and its passage was responded to at once by the agreement of the Chicago & Western Indiana R. R. to enter into negotiations for the elevation of its tracks. Up to the present time these negotiations have proceeded to the point where the railway company has prepared plans for the consideration of the city and agreed with the St. Charles Air Line on plans for removing the street grade crossing at Clark and 16th Sts.

Immediately following the agreement of the Chicago & Western Indiana R. R. to elevate its tracks, the various other roads whose plans for elevation are controlled by the plans of that line signified their willingness to meet the city half way. Among these are the Pennsylvania Co.'s lines, the Atchison, Topeka & Santa Fe, Illinois Central (Sioux City line), and the St. Charles Air Line. At the present time the negotiations with all these roads are in a very early stage, but the mere fact that they have been begun on a friendly basis is a long step toward the solution of the track elevation problem.

With the foregoing review in mind, attention can now be turned to the structural features of the track elevation problem. Unfortunately such data as can be secured are too few for more than a very general consideration of these features. Thus far the only railways which have done any actual construction are the Chicago, Rock Island & Pacific, the Lake Shore & Michigan Southern, and the Chicago & Northwestern, if we except the Illinois Central R. R., which elevated a portion of its tracks previous to the passage of the ordinance of Feb. 23, 1893, and isolated viaducts and subways constructed by some of the other roads. The character of the work done by the three roads named is a combined elevation of the tracks and depression of the streets (Engineering News, Oct. 11, 1894). Between streets the track elevation has been accomplished by raising the embankment, and at the crossings the streets have been depressed and the tracks elevated and carried over them by plate girder bridges with solid floors. The same character of construction was also adopted by the Illinois Central R. R. in its work, and it is probable that it will be followed by most of the other roads. On the south side of the city the Pennsylvania Company's lines, Atchison, Topeka & Santa Fe, Chicago & Western Indiana, Chicago & Alton and Illinois Central are all susceptible to this method of elevation.

The most difficult problems of elevation on the South Side are in connection with the St. Charles Air Line and the lines of the Union Stock Yards Co., all of which cross the city from east to west. Particularly difficult is the treatment of the St. Charles Air Line which crosses the various north and south railways and also the elevated line of the Chicago & South Side Rapid Transit Co. As already stated, this last problem is now under consideration, but no move has been made by the Union Stock Yards Co.

Of the western lines the Chicago, Burlington & Quincy and the Chicago & Northern Pacific Terminal have done nothing toward elevation. In fact the Chicago, Burlington & Quincy R. R. is reported to insist on remaining at grade and carrying the streets over its tracks by viaducts. The Chicago & Northern Pacific Terminal gives the Baltimore & Ohio, the Wisconsin Central and the Chicago & Great Western lines entrance into the city, and as the right of way is narrow and crooked, it has been suggested that a steel elevated structure toward the center of the city and embankment and subways further out would best serve its purpose.

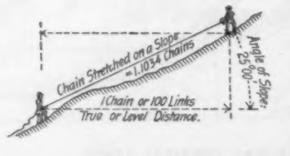
This leaves only the lines of the Chicago & Northwestern and the Chicago, Milwaukee & St. Paul railways to be mentioned. The Chicago & Northwestern has already elevated a portion of its Galena line running west and is ready to continue work on its north and south lines as soon as arrangements can be made with the city. As stated, the embankment and subway plan has been adopted. So far the Chicago, Milwaukee & St. Paul has made no movement toward elevating its tracks.

Summarizing briefly what has been said, it is seen that the city of Chicago has as the result of its work for track elevation so far, the elevation of the right of way of the Lake Shore & Michigan Southern and Chicago, Rock Island & Pacific railways, from Sixteenth St. to Sixty-first St., about 5⅓ miles, and of the Chicago & Northwestern Ry. (Galena Division), 1.7 miles. Including the elevation of the Illinois Central R. R., from Forty-seventh St. to Seventy-first St., about 10 miles of right of way, equivalent to 40 miles of track have been elevated. None of this elevation has been done within a mile of the terminal stations, and the most numerous fatalities are inflicted within this district now at grade. In addition to the work actually completed the city has begun negotiations as outlined above for the elevation of a half-dozen other lines, on which it is fair to presume work will begin during the present year.

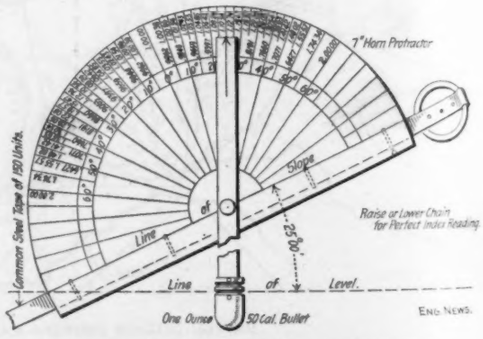
Turning to the legal condition of the problem it is found that no progress whatever has been made toward reaching a final conclusion as to the power of the city to compel track elevation. Every foot of track that has been elevated thus far has been done as the voluntary action of the railway companies, and according to plans approved by them. It is true that the pressure of public opinion and coercion in the shape of annoying ordinances can be brought to bear on the companies, and will, doubtless, be effective in the long run, but that does not alter the truth of the statement that the city has not proved its right to compel track elevation. Farther than this it is considered by good legal authority that a railway having once raised its tracks and paid money to the city under contract will obtain vested rights against interference, which will make the city still more powerless than it is now. All these things urge that that the most careful attention be given to the plans for track elevation now, since if they are once carried out no change is possible except the railways agree to it, and at the same time the fact that despite three years' work the most dangerous crossings in the city are yet at grade urges the utmost energy in urging the railways to haste.

Another thing which urges haste is the rapid substitution of cable and electric power for horse power on the city's street railways. A hasty computation shows that there are 172 main line crossings of street and steam railways in Chicago. These street railways are now either cable or electric lines or else rapidly being changed to those forms of power, increasing the danger from accident each day. Take, for example the Chicago & Western Indiana R. R. with four tracks carrying the trains of five large railway systems into Chicago, and consider the possibilities of accident with 17 cable and electric street railway crossings. This is, of course, an exceptional case, but yet it is not so far from being typical as might be supposed. Exclusive of the Chicago & Western Indiana R. R., no less than nine main lines of from two to four tracks each have 10 or more crossings of street railways each.

It is needless to repeat instances all of which show the same thing. Two opinions are forced upon one from the foregoing review. (1) track elevation is needed in Chicago more to-day than it has ever been needed before, and, (2) the work of the past three years, while promising much future good, has as yet hardly touched the district where track elevation is most needed.



Sketch Illustrating Method of Measuring Level Distances on a Slope.



Instrument for Measuring Distances on Steep Slopes. Designed by Isaac A. Seckard, Portland, Ore.

LETTERS TO THE EDITOR.

The Pawtucket Sewage Purification Plant: Correction.

SIR—In the article on the Pawtucket filter beds, in your issue of Jan. 2, the heading of the table of analyses should be Parts per 100,000 instead of "Parts per 1,000."

Yours truly,
Geo. A. Carpenter,
City Engineer.

Pawtucket, R. I., Jan. 18, 1896.

The Size and Style of Engineering Books.

Sir: I like your commendation of publishers for improving the form of engineering books, as expressed in your issue of Jan 9. Let us have clear type, light, strong paper, narrow margins, compact, strong binding, without any unnecessary bulk or weight, and with covers durable, plain, neat, and in dark, modest colors. There is no binding more attractive than that used for law books; is there not now enough demand for engineering books to make this calf binding available? Cannot each publisher, or all the leading publishers of engineering books, adopt three or four standard sizes for these books, so as to give them some uniformity on the shelf? Why waste money gilding on the backs such elaborate titles as most of our books have: such as "A Treatise on Hydraulic and Water Supply Engineering. J. T. Fanning. Van Nostrand;" "Thermodynamics, Heat Motors and Refrigerating Machines. Wood. John Wiley & Sons;" "Pumps, Historically, Theoretically and Practically Considered. Bjorling, Spon;" "The Elasticity and Resistance of the Materials of Engineering. Burr. Wiley & Sons," etc.

Walter G. Kirkpatrick.

Nashville, Tenn., Jan. 13, 1896.

A New Method of Chaining Slopes.

Sir: In catalogues of engineers instruments, I have never found a device for reading direct the true distance, or level distance, of a chain stretched along a slope.

The chained distance along the slope is frequently used and reduced to the level distance. It is believed this is good practice; therefore, why not multiply the unit distance, or 1, by the secant of the slope angle and carry the station in the slope ahead to the secant reading, which must correspond to a level distance? This will call for a longer chain, say 1½ times the unit distance; i. e.; A Gunthers chain should be lengthened to 150 links. In some rough mountain surveys this principle was applied with good approximate re-

sults: The "closings" on two mile runs, were much more satisfactory than the usual attempt at level chaining.

Our device was crude (see Fig. 1). A horn protractor was used for graduations. Along the lines of radii were scratched the secant and cosine of the angle. At the center a hole was punched, and holes were also made through a piece of steel tape and washers. In the hole a pin was inserted for the axis. One end of the piece of tape was marked as an index, the other end was weighted with a bullet for a plumb. Along the diameter edge of the protractor were punched holes and along these holes was bound the edge of the steel tape used for chaining. This tape was lengthened to 150 links by splicing on a piece of broken tape line. The figures on the protractor were scratched on the reverse side with a three sided sail needle; the holes along the edge of the chain were bored by the same needle.

The operation of chaining is simple: Fig. 2 is intended to illustrate the practical application. As the chain was stretched in alinement along the slope at a convenient distance from the ground, a plumb-line (at the hind end of the chain) was suspended from above the last station or pin; it also marked the required chain reading, as hereafter described: On the forward or zero end of the chain the attachment was fixed. As the chain was stretched along the slope, the slope angle was marked by the index arm of the attachment actuated by the plumb or bullet which dropped to the vertical. The secant is then read direct from the graduation on the instrument. The index arm had been adjusted to zero on the graduation, while on a perfect level, by shaving lead off either side of the bullet.

In practice the attachment went ahead. As the chain passed the unit distance of 100 links, the "hind-chain," called the chain reading until the point was reached which would coincide with the secant distance corresponding to the angle of slope; this distance was read on the graduation by the "head chain." When the secant distance and the chain distance agreed, "stick" was called and a pin was dropped as is usual in the level unit distance of one chain. The end of the chain should be raised or lowered a trifle to find the exact reading of the index with the graduation. This is rapidly performed. If the true or level distance of a broken chain on a slope is required, multiply the slope distance by the cosine opposite the index. When not in use the bob is swung to the ring and carried in the hand.

By this method accuracy depends upon the exact reading of the graduations; nevertheless, with the same care that is required in the level chain method in a rough mountain country, the results will be more satisfactory. The work will occupy less time, better alinement will be secured, and, as full chains are used the errors incident to a "broken" chain are eliminated.

Why might not this system be used in the U. S. Public Land Surveys? With this in view, manufacturers may perfect the "Leskard's direct level chain reader." It should be graduated to secant, cosine, angle and, perhaps, slope. The graduations should be on the upper surface of the cylinder, or top surface, for quick reading as the chainman braces himself for a tight chain. It may be hooked on either side to the handle of the chain when a quadrant or one set of graduations will suffice. The weight must be distributed and the plumb depended on for equilibrium. The plumb must be adjustable. The plumb and index arm should be incased. The instrument must be light, compact and cheap. I shall be happy to forward a sketch of my ideal to any maker of engineers' instruments on request.

J. C. Isaac Leskard.

University Park, Portland, Ore., Nov. 10, 1895.

Utilization of Anthracite Culm.

Sir: I was much interested in the article on "The Utilization of Anthracite Culm at Scranton, Pa.," which appeared in your issue for Dec. 26, and especially in the kindly criticism by your editorial correspondent of the figures given in my article in "Cassier's Magazine," on the same subject.

Some of the points taken by your correspondent seem to me open to question, but so far as they are criticisms of my article they may appear entirely justifiable, partly from the fact that what appeared in the magazine in question was but a short abstract of a somewhat lengthy report and therefore necessarily incomplete, and partly because even in my complete report I may not have made myself sufficiently clear.

I feel particularly pleased that your correspondent critizes my estimates of the cost of horse-power on the ground that they are too high, rather than too low, but at the risk of furnishing ammunition for those who might take the opposite view, I shall endeavor to controvert some of his arguments.

Taking up Mr. Atherton's estimate of the fuel consumption per HP. first, it would be interesting to know how he arrived at the number of HP. by which he divided his total fuel burned. Very few steam users know even approximately the number of horsepower hours they generate in a given time, and therefore their ideas as to the cost per horse-power hour are equally vague. In comparatively few industries does the average power used exceed 60 % of the maximum generated, and in estimating the cost, the manufacturer who has a 100-HP. engine, and actually uses on an average but 50 or 60 HP., divides the total cost of power by 100 and gets misleading results. It would be interesting to know how far, if at all, Mr. Atherton in his estimates has fallen into this same error.

The figures 4.37 lbs. culm. per horse-power hour, which are deduced from his estimates, I should regard as exceedingly good for the best of coal under ordinary conditions of practice, where the load was anything but constant. The effect of variable load on fuel consumption is well illustrated in electric lighting practice, where engines capable of generating a horse-power under steady load on 1¼ to 1½ lbs., seldom do it under the actual service conditions, on less than 4 to 6 lbs., and often require 8, 12 and even 25 lbs. The effect of variable and frictional loads is even more apparent in the labor and interest charges than it is in the coal pile for the reason that these items, which under favorable conditions might be divided by a maximum horse-power, must be charged to but a fraction of the same.

In making estimates of the cost of power it is almost impossible, if not quite so, to provide for all contingencies without appearing to make undue allowances in some of the items tabulated. Thus, while I may have charged entirely too much for chimneys, considering that forced draft was postulated, this overcharge is likely to be counterbalanced by contingencies not provided for. I am criticized for estimating the boiler capacity with culm at only 85 % of the capacity with good coal, your correspondent stating that I do not "distinguish between rated capacity and actual capacity in practice, which with forced draft, is apt to be nearly or quite double the rating." It seems to me that he forgets that the only way culm can be burned is with a forced draft. The boiler fired with culm is therefore normally forced to the utmost—there is no reserve; whereas, if fired with good quality egg or nut coal it would normally give quite as good an output without forcing and have a reserve, as he says, of 50 or 100 %. I do not see how it can be successfully maintained that a boiler fired with culm is the full equivalent of the same boiler fired with first-class fuel. And then there is another point, viz.: that where fuel is exceedingly cheap, as at Scranton, it is folly to install high economy boilers, for the reason that the interest on the extra investment involved in the latter, amounts to more than the economy in fuel amounts to. Such a situation is preeminently the place for cheap boilers and engines—preeminently the place where fixed charges should be reduced to a minimum.

In my estimate the Lackawanna Iron & Steel Co. is charged with $2.45 for the removal of ash and the Dickson Mfg. Co. only $0.95. Your correspondent calls attention to this apparent discrepancy and gives some figures which seem to show its absurdity. I may premise further remarks by stating that these are not my figures but those of the committee of the Scranton Engineers' Club, who gave them as they found them. The apparent discrepancy had also attracted my attention before making my report and I sought an explanation which I found in this. In the first place the facilities for handling the ashes at the Dickson works are far superior to those obtaining at the other place, and in the second, the amount of material handled at the former is much less per ton of fuel consumed than at the latter. The reason is that at the Dickson works the material used is all fine—there being nothing larger than No. 2 buckwheat, I believe. The result is that when it is necessary to rock the grate bars, very little but ash passes through. On the other hand, at the L. I. & S. Co. unsized culm is used, and the material varies in size from dust to stove coal. When the finer sizes have been fully consumed, necessitating the dumping of the grate, the larger sizes are but partially so, and the result is that the ashes often contain upwards of 30 % of unconsumed coal. This means, of course, the handling both of more coal and of more ashes, the effects of which are apparent in the figures given for firing and removal of ash.

Nelson W. Perry' E. M.

Hillsdale, N. J., Jan. 6, 1896.

(We referred the above letter to Mr. Atherton, and append his reply, as follows.—Ed.)

Dear Sir: Answering the query of Mr. Perry as to how I arrived at the number of horsepower by which I divided the total fuel burned, I would say that my statistics on the cost of fuel per horsepower at Scranton, Pa., were obtained by taking from the books of the different concerns the horsepower required to run, and the number of tons of fuel consumed, at eight collieries in this vicinity, also at several of our large manufacturing plants (not electrical).

It is a well-known fact among us who are familiar with coal preparation, that in a colliery the load is steady and uniform at all times. In the other concerns mentioned the figures represent as nearly as possible the actual number of horsepower regularly employed.

In all of the collieries old-fashioned cylinder or locomotive boilers are used; and, in fact, at the time these statistics were compiled none of the concerns from which figures were obtained had late improved steam plants in use.

In conclusion, we are informed the Suburban Electric Light Company of this city quotes electrical horsepower in small units, delivered at $25 per year, 24-hour days, six days per week, and in larger units at correspondingly low rates. These figures are less than Mr. Perry claims it costs to generate the power, but I can assure your many readers that this concern is not in business simply for pleasure.

Respectfully yours,

D. B. Atherton,

Secretary, Scranton Board of Trade.

Scranton, Jan. 18, 1896.

(We may say further, in reply to Mr. Perry's letter, that the figures "4.37 lbs. of culm per H.P. hour," to which he objects, are actually reasonable for loads approximately uniform loads, for with engines using as much as 30 lbs. of steam per H. P. per hour this would be equivalent to less than 7 lbs. of water evaporated per lb. of coal. In making comparative estimates of cost of fuel per H. P. at different locations, a practically uniform load must be assumed, and then allowances must be made for any particular case, such as a small electric lighting plant, in which the coal consumption may, as Mr. Perry says, amount to 8, 12, and even 25 lbs. per H. P. per hour. No proper average can be made of these figures, and no estimate of relative cost of culm and other fuel can properly be based upon them. We must take exception to Mr. Perry's statement that, because the only way culm can be burned is with a forced draft, therefore, a boiler fired with culm is normally forced to its utmost. Forced draft is one thing, and forcing a boiler is another and entirely different thing. A boiler is forced when it is made to evaporate a greater quantity of water than its normal rating. It is fired with forced draft, when a fan or steam jet is used to force the air through the bed of coal on the grate, instead of relying on the natural draft of a chimney. It is difficult to say when a boiler is forced to its utmost. Boilers have been driven at a rate exceeding 10 lbs. of water evaporated per square foot of heating surface per hour, or upward of three times the ordinary rate, but their "utmost" may be a much higher rate. Boilers fired with forced draft are commonly worked at a much lower rate of combustion than the steam jet or other apparatus by which the draft is produced is capable of producing, a reserve of extra pressure being on hand for emergencies. This reserve of power is in fact one of the chief recommendations of the forced draft system.

In regard to the figures $2.45 per H. P. for removal of ash, we can only say that if they are correct figures they are entirely too high for good practice, even if the fuel contains as much as 30% of refuse. If these figures are correct for any particular plant, then the managers of that plant should make an effort to reduce them.—Ed.)

The Capacity of the East Jersey Water Company's Conduit.

Sir: In your issue of Dec. 19 you publish a letter from Mr. Clemens Herschel to the president and board of directors of the East Jersey Water Co. regarding the deficient carrying capacity of their 48-in. steel water-supply main. In explanation thereof Mr. Herschel states that he based his original computations upon the observations on the discharge through the Rochester Water Supply conduit made in 1876 and upon the digest of all attainable data concerning riveted pipe, as given by Hamilton Smith in his book called "Hydraulics," pp. 270 and 272. He further says:

The (Rochester) City Engineer's report of 1877 had deceived all the engineers and writers on hydraulic engineering here and in Europe who had given the carrying capacity of riveted pipe any attention. This report, such as it was, became standard authority, being an official report, and was taken as the truth for 14 years. . . . It merely demonstrates that all writers and workers in this line for 14 years then past (1891) had been equally misled by the erroneous statements of the Rochester Water Works Report of 1877.

Such statements as these, unless explained, are apt to reflect discredit on a branch of hydraulic engineering which it does not deserve. It would appear, according to Mr. Herschel, that the Rochester gaging had been taken as standard authority and stood unquestioned by hydraulic engineers, whereas I believe that until the gaging was criticized by Mr. G. W. Rafter in a paper: "On the Hydraulics of the Hemlock Lake Conduit of the Rochester Water Works," read before the American Society of Civil Engineers in January, 1892, few engineers in this country and in Europe knew of such a gaging. Moreover, it was not a simple but a compound pipe, 36 ins.

and 24 ins. in diameter, was partly of wrought iron, riveted and partly of cast iron, and the details of the gagings, as recorded, were quite meager.

When, in 1888, I was preparing for publication a table of gagings of the flow of water in pipes with different interior surfaces, I read Mr. Hamilton Smith's book with expectations of receiving great help, but while his actual gagings appeared to be quite trustworthy, I was much disappointed with his reasonings and deductions, particularly in that part of the book which treats of the flow in pipes. It seemed that in his praiseworthy effort to attain almost theoretical precision, he had failed to appreciate to the full extent the modern and practical methods of ascertaining the discharge, based on its gradual variation, conforming with a gradual change in the nature of the wetted perimeter. Others were similarly disappointed.

I have already taken several opportunities since first studying the question in 1876 to call attention to the unsatisfactory results obtained by using the older formulas and practices when ascertaining the probable discharge of pipes, and it seems that here is another case which teaches the same lesson. The discrepancy reported in the capacity of the East Jersey Water Co.'s 48-in. conduit, may, I think, be explained, as shown below, by the character of the interior surface, the importance of which was first demonstrated about the year 1865 by the experiments of Darcy and Bazin, and made practically useful by the empirical formula of Ganguillet and Kutter, first published in 1869.

In order to aid engineers in estimating the probable capacity of pipes and open channels, the writer, together with Mr. John C. Trautwine, Jr., collected all the available and fairly reliable gagings that had been recorded and could be obtained up to the year 1888, and published them as an appendix to their translation of Ganguillet and Kutter's work on the Flow of Water.

From the data therein contained we may draw the following conclusions with reference to the carrying capacity of a pipe such as the one in question:

The gagings show a much greater discharge for new pipes than for old ones where the interior surface has become roughened and tuberculated by corrosion, or coated with vegetable growth. The formulas or tables for the flow of water in new pipes, many of which have been published by different authors, must, therefore, be used with intelligence as well as caution, and the results in every instance applied with a suitable factor of safety, unless the favorable conditions of the pipe are positively known to remain constant. In the above-mentioned collection, I therefore considered it of value to give actual gagings also of old pipes, with different degrees of corrosion, and channels with artificially roughened surfaces.

In order to compare the case of the East Jersey Water Co's conduit with other cases, we can assume its elements to be as follows: Hydraulic slope: 0.002; diameter of smallest ring: 47¼ ins. About every 7 ft. there is a lap of the plates, causing a projection of from ¼ in. to ⅜ in. around the entire interior surface, and also a row of projecting rivet heads. The interior surface is coated with asphalt and is said to be still quite smooth. The conduit was designed, by calculation, to be capable of delivering 50,000,000 gallons daily. It is now found, by experience, to be capable of furnishing only 35,000,000 gallons with a mean velocity of 4.45 ft. per second.

The following actual gagings, made prior to 1888, were taken from the above-mentioned collection for the present comparison:

In 1885 Mr. F. P. Stearns, in the "Transactions of the American Society of Civil Engineers," published the results of a gaging made in a 48-in. pipe of cast-iron, coated with asphalt, with a clean surface and no interior projections. The velocities under different heads varied from 2.6 to 6.2 ft. per second and the coefficient of roughness (n) was found to vary from .0105 to .0109, this result, if applied to the East Jersey Water Co.'s conduit, would give a mean discharge of 49.2 million gallons per day.

By applying the results of the gagings of Mr. Brush, in 1882 to 1887, of a new cast-iron main, 20 ins. in diameter, at Hackensack, N. J., with a velocity of 3 ft. per second and a coefficient of roughness (n) = .0127, the conduit in question, with the same coefficient, would have discharged 41.3 million gallons per day. This pipe had a large number of angles, summits and curves.

Such records as these we see cannot be applied to the East Jersey Water Company's conduit because the latter has, every few feet, a projecting lap of about ⅜ in. and rows of rivets protruding in the interior.

The effect of such small projections upon the velocity in a pipe seems to be, even now, hardly sufficiently appreciated. Darcy and Bazin first called attention to this effect. In order to indicate the great difference of flow in smooth channels and those having small projections, I append the results of some of their carefully made gagings, selected from among many, so as to correspond fairly well with the case in question, and such correspondence is sufficiently close for the present purpose. The value of the coefficient of roughness (n) was, of course, obtained by the experiment. Applying it to the conduit in question, its discharge is computed for each case. The other gagings mentioned herein are also embodied in this table:

It will be seen from these gagings how greatly the flow is influenced by the character of the surface upon which the water flows. It should be particularly noticed what a large difference there is in the flow when the laths are ⅜ in. or when they are 2 ins. apart. In the latter case the resistance to the flow is very much greater. The case of the pebbles is inserted here particularly to show the smaller effect they have upon the coefficient of roughness than where the laths are 2 ins. apart.

These gagings, in my judgment, conclusively demonstrate, if demonstration were yet needed, that pipes with lapped joints, projecting ⅜ in., and with velocities over 4 ft. per second, must produce a high coefficient of roughness.

It has always seemed to me of great use to compare the actual gagings of as many cases as possible, even if they do not all exactly correspond to the case in question, because they are apt to indicate the law of variation of the coefficient to be used, which is important, and with which it is possible, guided by the exercise of judgment, to get closer to the truth than by not considering such a law.

Further, it is especially useful in this respect to employ Kutter's coefficient of roughness (n), as determined by actual gagings, in forecasting the probable flow in a pipe, because it is mainly dependent upon the character of the surface, and can therefore be better appreciated than, for instance, the Chezy coefficient, which has embodied in it also the effect of a number of other influences.

It is curious to note the results of the last gaging in the table made at Holyoke in 1887 by Mr. Herschel himself, and given in his excellent paper on "The Venturi Meter" in the "Transactions of the American Society of Civil Engineers," Vol. XVII. I considered this gaging of sufficient value to embody it in the appendix to the above-mentioned translation, while I left the Rochester gaging out or the reasons stated above. The first named was the only case of the kind I could find and resembles this conduit more closely than any other, so far as the influence of projections is concerned. The gaging was made in a riveted pipe 8.58 ft. in diameter, with the plates lapping and projecting about as much as in the case of the New Jersey conduit. For velocities ranging from 4.00 to 4.50 ft. per second, similar to those of the case in question, the coefficient of roughness (n) is found to be .016. Had Mr. Herschel applied this coefficient to the New Jersey case, he would have obtained a discharge of 32 million gallons as the probable capacity, which pretty nearly agrees with what has actually been found. He did not use the results of his own experiments for reasons given in his paper referred to above.

Says he: "I judge from the disagreement of the results above given with those found at other places, but on longer tubes, either that piezometers do not correctly indicate the h of the formula (see Hamilton Smith's "Hydraulics"), or else that a uniform and non-accelerative regime of the flow of water through the trunk had not become established in the comparatively short length at command for purposes of measurement. This latter circumstance, would, in most cases, prevent any attempt to compute the flow of water through mill trunks and in many cases of city water pipes, by the use of the formula $v = c\sqrt{rs}$, or of any other formula for the discharge of pipes, whose general coefficients can only be established for the case of a perfectly uniform permanent flow; three modifying conditions, namely, those of perfection, uniformity and permanency, which are very difficult to attain in practice."

To fulfill the terms of the contract and deliver 50,000,000 gallons, I understand Mr. Herschel proposes to lay another pipe parallel to the present one, and has already built 1⅛ miles of 42-in. pipe, with so called "taper joints." Experiments with this new pipe will furnish interesting results in comparison with the present one, by showing the difference in the effect of up-stream and down-stream projections. By laying a sufficiently long portion of the new pipe with butt joints and countersunk rivetheads, thus giving it an even and smooth interior surface, somewhat resembling case No. 2 in the above table, experiments would by comparison demonstrate the effect of any such projections on the capacity of a conduit.

Yours truly,

Rudolph Hering.

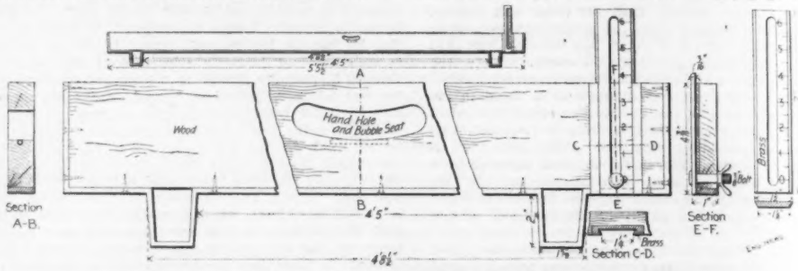
277 Pearl St., New York Jan. 19, 1896.

Computed Discharges for a Circular Conduit with an Hydraulic Slope of 0.002 and an Effective Diameter of 47¼ in.

No.	Author.	Description of Wetted Perimeter.	Coeff. of roughness (n) (Kutter).	Discharge in million gallons per day.
1	Assumed for E. J. W. Co.'s conduit) (1889)	Steel rings about 7 ft. long, riveted with lapped joints, thickness of plates ¼ to ⅜ in.	.0106	50.
2	Stearns (1885)	New cast-iron pipe, near Boston; very easy curves, coated with asphalt, clean.	.0108	49.2
3	Brush (1882-87)	New cast-iron pipe, in New Jersey; large number of summits, angles and curves, coated with asphalt.	.0127	41.3
4	Darcy and Bazin (1865)	Test channel of neat cement.	.0103	52.
5	" "	" " planed boards.	.0118	44.8
6	" "	" " lined with pebbles ⅜ to ¾ in. diam.	.0169	30.
7	" "	" " " with laths 1 by ⅜ in. nailed crosswise to current, ⅜ in. apart.	.0154	33.4
8	" "	Tested channel lined with same laths 2 ins. apart.	.0216	22.9
9	Herschel (1887)	Wrought-iron flume at Holyoke; rings about 4.5 ft. long, riveted with lapped joints, thickness of plates 0.03 ft.	.016	32.

GALBREATH'S COMBINED TRACK GAGE AND LEVEL

The accompanying cut represents a useful combination track tool, which is at once a track gage, guard-rail gage and track level. It is a wooden board 1 × 4 ins., faced with an iron strip 3-16 in. thick extending over the bottom edge, gage lugs and ends, and secured by screws. The length over all is 5 ft. 5½ ins. The gage of track and guard rails is measured respectively over the outside and inside of the lugs, as shown, the lugs being 2 ins. deep and 1⅞ ins. to 1⅝ ins. wide. At the middle of the board is a handhole, with a spirit-level tube set in the lower seat. At one end of the board is a plate sliding vertically in dovetailed guides, and held at any position by a nut on a ⅜-in. bolt. A graduated scale is marked on the slide, and in testing the superelevation of curves the slide is lowered to the amount of elevation required, this end of the level being then placed on the inside or low rail, and the outer rail then raised or lowered until the spirit-level bubble is in the center of the tube. By the attachment of a straight rod 3½ ft. long, held in position at the gage line by a semi-circular arc, this tool is a great assistance in lining tangents. By making the iron strip in two pieces, separated by a space of about 2 ins. at the middle, the tool is sufficiently insulated to enable it to be used on roads having automatic signals operated by track circuits.



GALBREATH'S COMBINED TRACK GAGE AND LEVEL; W. VA. C. & P. RY.

The device was designed by Mr. J. W. Galbreath, Chief Engineer of the West Virginia Central & Pittsburg Ry., specially for the use of the track supervisors, but it was found to be so useful that it was made in somewhat lighter form and put in the hands of all the section foremen. We are indebted to Mr. Galbreath for the blueprint from which our illustration is taken.

PULSATIONS IN WIND PRESSURE.

The effect of wind pressure upon high structures, and especially varying values and abrupt changes in pressure, are peculiarly interesting at this time, and the information upon this head is so meager that any new data must be welcome. As a contribution to this study, Prof. L. G. Carpenter, of the Engineering Department of the Colorado Agri-

cultural College, at Fort Collins, Col., sends us the diagrams here reproduced.

These diagrams are taken from a magnifying barometer, or "statoscope," a form of aneroid barometer which magnifies the variations in pressure ten times. The vertical scale indicates pressures; the horizontal, time; the heavier lines show

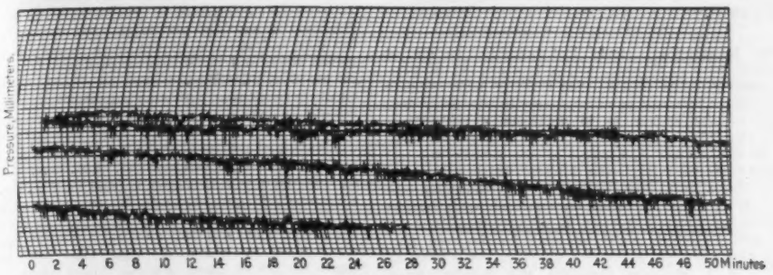


Diagram No. 1.

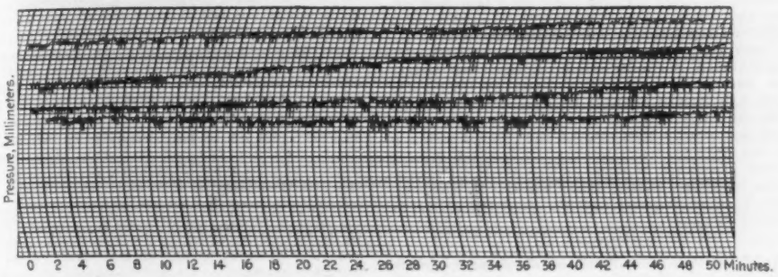


Diagram No. 2.

DIAGRAMS FROM SELF-REGISTERING STATOSCOPE, SHOWING PULSATIONS IN WIND PRESSURE.

periods of two minutes, and the smaller ones 30-second periods.

Sheet No. 1 was placed on the instrument and the clockwork was started at 10.30 A. M.; and sheet No. 2 was put in position at 2.45 P. M., one revolution not being shown, due to exhaustion of ink in the pen. During the time of observation the wind velocity per hour, as shown by an anemometer, was as follows: 10.11 A. M., 48 miles; 11.12 A. M., 49 miles; 12.1 P. M., 52 miles; 1.2 P. M., 49 miles; 2.3 P. M., 48 miles. From 3 to 6 P. M. the velocity for each hour was at the rate of 44 miles per hour.

The abrupt changes in pressure are associated with the more violent gusts, and their frequency, amounting to at least 8 or 10 variations in 30 seconds, show the gusty character of the wind. The hourly velocities, however, show a considerable uniformity in the total movement: It will be noticed that nearly all the changes indicate a decrease, and not an increase of pressure, sometimes amounting to a full millimeter, and this change is instantaneous. During quiet weather the record is a smooth line.

OPERATING ELECTRIC LIGHTING PLANTS WITH MODERN APPARATUS.*

Two things which are constantly changing the conditions of electric lighting plants are the development of new apparatus, and the reduction in price of supplies.

The money earning station fits its apparatus to its service; not the service to the apparatus. If you charge $10 a month for a 2,000 c. p. arc lamp and your customer regards you as a robber, it would seem expedient to furnish either a smaller arc, or a big incandescent lamp service at meter rates, thus reducing the price, but not the proportionate profit. A big cut in your 2 000-c. p. rates will transform that service into non-paying investment, while a service of half the candle power, at half the cost of production, will pay a profit. The big incandescent lamp is a money making factor ignored by a majority of operating stations, either thorough lack of knowledge or appreciation of the fact that efficient 100 to 500 C. P. lamps are selling at a price that commends their use.

One of the chief elements of competition in lighting at present is the Welsbach gas burner, and this competition has come to stay; not, perhaps, in its present form, but in a new and improved burner, which eliminates some of the many glaring faults of the original. The quicker this competition is met, the easier and cheaper it is overcome. The president of the Calumet Gas Co., of Chicago, operating the second largest arc plant in this country, thinks the strongest competing service is an arc system with 500-c. p. arc lamps, $\frac{7}{16}$-in. carbons, at $5 per month. We may assume that it is unnecessary to buy the gas company; or to sell your holdings at a sacrifice. When the Welsbach fad strikes a town it lasts about nine months, and usually displaces one-third of the electric lamps in service, which, owing to the many objections of the burner, developed in its use, gradually return, until the former output is reached, if not passed, by the demand created for a more liberal illumination.

The first change found necessary in your operation is to increase the candle power of your lamps to a competitive brilliancy. When 16-c.p. lamps sold at 35 cts. this might prove disastrous, but with better lamps at 18 cts. each, it becomes a necessary virtue, and the increased voltage will run your meters fast enough to make up the added expense, provided you sell your current through meters In this connection the advisability of accurate switchboard instruments and their periodical calibration with a standardized instrument is clearly shown; as a comparison of the station output with the receipts, will immediately uncover any leakage in the revenue.

The increasing of your pressure will disclose, if your experience has not already proved it, the inefficiency of small transformers of any make. The ground losses on the line and the copper and iron losses in the transformers of the ordinary alternating station are uselessly and unnecessarily large. Four out of seven stations tested by me in the past three months for their constant load loss, have shown that less than two-thirds of the current generated reached the lamps. One station employing a 90 KW, 1,800 light 1000-volt alternator, with 1,842 lamps wired, gave an output of 70 amperes at the switchboard when 840 lamps were burning. The lamps, which were all of one make, were counted between the hours of 7 and 8 p.m., when the customers were requested not to turn off or on any lamps in that interval. The test showed that current for 1,400 lamps had generated at the station with a constant load loss of 28 amperes. This loss should not exceed 8 amperes. The current at the switchboard running 840 lamps should have registered 50 amperes, all of which would indicate that this station ran with a constant load loss of 20 amperes, or current enough to supply 400 lamps of 16 c. p., for which the station received no pay. This useless loss was eliminated by putting triple petticoat porcelain insulators in place of the single petticoat glass insulators; removing one fixed and one intermittent ground on the line, and changing 1,400 lights of 5, 16 and 25-light 50-volt transformers to two 250-light, eight 100-light and two 50-light 100-volt transformers. The balance of 400 lights were on the residence circuit, and were changed from 50 to 100 volts without materially decreasing the size of the transformers. When these changes were completed, the output at the switchboard was 51 amperes with 898 lamps burning. While formerly most of the output was sold at a given rate per lamp per month when the change was made every lamp was put on meter, and the losing station converted into a paying property.

Increasing the candle power will apply to the same extent in meeting ordinary gas competition. We know the public is willing to pay a fourth to a half more for electric light than gas, provided they get full candle power. Taking gas and incandescent electric lamps at equal candle power, the equivalent rates would be $1, $1.50 and $2.00 per 1,000 ft. for gas and ½, ¾ and 1ct. per hour respectively for 16 c. p. lamps.

The best protection to the value of your property and its revenue is to keep it modernized. This contemplates a continuous expenditure anticipated and met by the money earning plants. The development of the business has demonstrated the economy of large units. In arc service the 100 to 125-light machines have displaced the 35 to 50-light units with a saving in maintenance of 40%. In direct current service the large units effect a saving in maintenance of 20%, which is increased up to 50% by being direct connected. In alternating current service the large units effect a less apparent saving in current efficiency; but the slower speed, lower temperature and ability to run continuously makes their adoption a commercial gain, apart from the simplification of circuits.

Speed and weight should govern the price of all types A dynamo running at 600 revolutions weighs nearly twice as much as one of the same design and rated capacity at 1,200 revolutions. It costs 70% more to build. Hence, a direct connected dynamo at 275 revolutions is worth 70% more than a belt driven machine of the same design at 550 revolutions. When the armature is built directly on the extension of the ordinary engine shaft, this may be reduced to 50% on account of doing away with one box pedestal and part of the frame.

The rating given a dynamo by the maker should not always be accepted. The various machines offered should be placed on the same basis of estimating their capacity namely, assuming the highest point of efficiency as full load, the added capacity of the machine beyond that should be regarded as an overload. Most dynamos are rated at their utmost capacity, irrespective of efficiency or temperature. A 150 KW. alternating dynamo rated at 130 amperes and 1,150 volts is worth but 80% of one of equal quality rated at 150 amperes and 1,000 volts; the first being the output at the dynamo; the latter the output at the center of distribution where it belongs. This difference in actual value is reduced to 75% if the first dynamo is rated at full capacity, and the latter at its most efficient output.

The Harrison St. station of the Chicago Edison Co. has shown an extraordinary reduction in cost of current per kilowatt-hour by the use of direct connected machinery; but the units are from 500 to 1,500 KW. A fair estimate of the added saving in the use of direct connected apparatus would be 10% in a 100-KW. machine, 20% in a 200-KW., 30% in a 300-KW., 40% in a 500-KW. and 50% in a 1,000-KW. machine.

In buying arc apparatus the speed and weight should also govern in nearly the same degree the price of the largest size you can use. The pressure which reaches 6,500 volts in a 125 light arc dynamo seems to be carried on the ordinary arc circuit as easily as 3,000 volts. Of course, 6,000 volts will jump nearly twice as far and, theoretically, would require twice the insulation to hold; but experience has shown that if an overhead arc line is built to protect a pressure of 3,000 volts it will carry 6,000 volts with safety. No reliance whatever is placed upon the insulation of the ordinary No. 6 overhead arc line, which should be erected as if the wire was bare, as almost all such lines five years after erection are bare, so far as insulating qualities are concerned. The weak spots requiring increased insulation are the wires from the pole to the lamp or entering stores, and these wires should have a high grade rubber insulation, as the regular weatherproof line wire will give constant trouble even when protected with porcelain or hard rubber bushings or flexible tubing. It is not necessary to use rubber insulation throughout your overhead arc line, even with 150-light arc machines.

When the purchaser comes to buy alternating apparatus he is confronted with single phase, quarter phase two phase, three phase, multiphase and monocyclic With the use of an efficient motor the single phase is the ideal alternating current system; no condensers; no balancing of the load; no fixed arbitrary line loss, but two wires on the line, all giving a flexibility that affords a minimum cost in power, arc and incandescent service from the same machine and circuit.

All the catalogues of multiphase apparatus contain a statement, variously expressed, that a single-phase synchronous motor is the most desirable but attainable type This is no longer true as to its unattainability. Single phase motors are now sold on the market having as high a commercial efficiency as is obtained in any but the large types. They are self-starting at full load with maximum torque; they require no special circuits or connections; no starting rheostat, no condenser, and no special transformer; the ordinary lighting transformer answering the purpose. Being in step with the generator, the regulation of the synchronous motor is perfect under all loads and the motor will pull out of step and stop running if more than a 50% overload is applied.

The phase affects the units in which your power is distributed, and idle currents, etc., develop as the size of the

*Abstract of a paper by W. J. Buckley, read at the annual meeting of the Northwestern Electrical Association at Milwaukee, Wis., Jan. 15 to 17.

self exciting motors increase, practically limiting the distribution of power on a single phase circuit to motors no exceeding in size 100 HP. The single phase generator may be a 1,000 HP. machine, but any one of the motors must not be larger than 100 HP., unless independently excited and started. So far as the phases are concerned, the only conditions under which a multiphase system is more applicable than a single phase is in the transmission of very large amounts of power over great distances, and where the power is distributed in several units.

Generally speaking, the higher the frequency the better the lighting service. The frequency of 3,600 alternations per minute or 30 cycles per second is suitable for power only, and will not commercially operate an arc or incandescent service at all, because the low period current waves produce an undulating and decidedly fluctuating light. Power is practically limited between 20 and 150 cycles per second or 2,400 and 18,000 alternations per minute, because lower frequencies reduce the speed and increase the weight of motors and transformers beyond a commercial economy, while higher frequencies prevent getting the necessary number of pole pieces within an efficient compass or radius. In the alternating arc lamp the high frequency makes an audible hum, with a distinct "pitch" of tone more or less musical; the low frequency reduces this tone "pitch" and increases the volume. This noise is partially eliminated by using a special transformer for arc service only. There is a special arc transformer on the market that will feed a steady current through the ordinary $7 carbon, dispensing with the $20 to $30 cored carbon, and reducing the cost of carbons $7 per year in single carbon and $14 per year in the double carbon lamp; giving an equally good service without the use of resistance or economizing coils with their corresponding waste of energy.

Running any make of alternating arc lamp from the incandescent transformer has not yet produced a competitive arc service, and the application would resolve itself into the use of the regular arc dynamo and lamp where the number of lamps exceeds 40. When an alternating station has an output of a few arc lamps, by all means use the alternating arc with a special transformer permitting the use of the ordinary carbon, but when you can sell more than 40 arc lamps the saving of the current lost in conversion and the single wire circuit of the regular arc system must then commend itself.

The alternations also affect the ordinary transformer. Only two makers, to my knowledge, build a transformer especially for 7,200 alternations. All the other manufacturers build a tranformer designed for high frequencies; and without altering the patterns of construction beyond a few trivial changes to make room for the necessary added ampere turns of wire offer a transformer presumably suitable for any frequency. If the user has a high frequency current, this type of transformer will consume 50% more magnetizing current than one designed only for high frequency. If he applies the high frequency transformer to the low frequency current, the lack of necessary ampere turns of wire or weight in iron makes the loss in magnetizing current still greater and the transformer will become hot.

The quick repair transformer wherein the iron field is split in two, so the coils can be readily replaced, is too dear at any price, the broken magnetic circuit causing too great a loss of current in energizing the transformer, apart from the charring of the insulation by the excessive heat generated. Electrical apparatus built to repair easily soon develops a determined disposition to accomodate you.

The following notes are suggested to probable buyers of new apparatus:

1. Buy direct connected apparatus if the size of your station and the money available will permit.

2. If your means or present arrangement of power suggests the purchase of belt-driven dynamos, buy the heaviest, slowest speed machine of the largest capacity practicable.

3. Use 2½ watt lamps; 2 watts if you can buy them.

4. If your power service is in small motors, none of which are larger than 50 H.P., use single phase apparatus; if in motors larger than 50 H.P. use multiphase.

5. If the proportion of lights is greater than power buy high frequency apparatus; if power is the most important service, buy low frequency.

6. Use the largest transformer practicable having the best regulation consistent with minimum loss on no load.

7. Sell all your current through meters and check up the station output with your receipts.

The right of a water company to collect water rents when it supplies water unfit for domestic use has just been reviewed by the Supreme Court of Pennsylvania. The Butler Water Co. takes water from brooks which have recently been polluted by the discharge into them of large quantities of salt water from oil wells. The lower court found that the water was so salt as to be unfit for either domestic uses or steam-making purposes, and enjoined the company from collecting rents for water used for such purposes. The Supreme Court sustained the injunction, saying, "If the commodity bargained for is not delivered, it is elementary law that the price is not recoverable."

The water company at the same time brought suit to stop the pollution of its sources of supply by the oil producers, but the lower court denied the application. The water company was thus placed in the position of being compelled to furnish pure water, yet denied protection against those who would pollute its supply. The Supreme Court, however, has wisely reversed the latter decision, and declared that in view of the company's public service it is probably entitled to an injunction against the oil well owners.

The topographic and hydrographic survey of Chatham county, Georgia, which was started in 1890, and afterward discontinued, has recently been resumed by placing a large corps of engineers in the field. The object of the survey is to establish a basis from which the work of draining large areas of swamp land can be carried on. The whole of the county lies but little above water-level—the highest point being but 60 ft. above mean low water ,as established by the U. S. Coast and Geodetic Survey—and with proper ditching and the construction of tidewater gates much land now valueless might be used for farming purposes, and particularly for rice growing. As a basis of operations a principal meridian and parallel were run, crossing each other at the City Exchange, of Savannah, Ga., and dividing the county into four unequal parts. From the intersection as a zero point meridians every 3,000 ft., and parallels every 2,000 ft., run, with a transit , and then levels taken. Meander lines are then run along roads, streams and swamp lines. The surveys, being transferred to topographic sheets, give lines of drainage with great accuracy, and enable the location of the tidal gates. A part of the county has already been ditched and drained and further and quite extensive work will follow the present surveys. The work is done by the County Commissioners, who use convict labor mostly. M. Geo. W. Brown is Chief Engineer and Mr. Hayward Ranuel is Assistant Engineer.

An appropriation for a Pacific telegraph cable is being urged before the House Committee on Interstate and Foreign Commerce by Mr. E. L. Baylies, of New York, acting in support of a bill now before Congress. As proposed, the cable would start from California or Oregon and proceed, 2,097 miles, to the Hawaiian Islands. From there the line would run to the Marshall Island, 1,991 miles, and 2,502 miles further to Yokohoma. The total length of this cable would be 6,590 miles and the estimated cost, ready for operation, is $7,500,000. The U. S. Government is asked to assist in this enterprise by appropriating about $175,000 annually for 20 years; and during this same period the Japanese Government is being asked to appropriate $200,000 per year. Another Pacific cable enterprise, backed by Mr. L. L. Spaulding, of the Hawaiian Islands, is also before Congress.

The existing deficiences of the battleship "Texas" built by the government at the Norfolk Navy yard are thus pointed out by Secy. Herbert: The inspecting board recommends the fitting of docking keels, as are now provided on all new battle ships; that various bracket-plates named be stiffened and that additional water-tight doors be provided to facilitate communication between fire rooms and in passing coal from one side of the ship to the other. The feed-pumps are not efficient and the leakage of steam in the hydraulic pump-room must be stopped by overhauling the piping and packing. The location of the 12-in. magazine between the fire rooms is considered as being too hot, and a change easily made, is recommended. When these changes are made, says the board, the "Texas" will be a first-class ship.

The three 15-in. pneumatic dynamite guns recently erected at Fort Winfield Scott, near San Francisco, Cal., have been tested and accepted by the government. In the tests 11 loaded projectiles were fired; 3 charged with 500 lbs. of explosive gelatine each, and 8 charged with 100 lbs. of the same; 15 dummy projectiles of full caliber and weight were also fired. The official report says that 44 rounds were fired in 52½ minutes in the test for rapidity of fire; the air pressure falling from 2,000 lbs. per sq. in. in the storage reservoir to 1,780 lbs.; the pressure used in the gun was 1,000 lbs. per sq. in. The guns were rapidly traversed and elevated by electric power. The 8-in. sub-caliber shell, loaded with 100 lbs. of explosive, traveled very steadily; but the 15-in. full-caliber shells were unsteady in flight, although they never failed to explode on touching the water. The maximum range with the 100 lb. shell was 5,070 yds., or about three miles; and for the 500-lb. shell the range was 2,170 yds. A summary of the shots showed that 75% of the shells fell within a rectangle, 360 × 90 ft. Two shells with 100 lbs. of explosive were fired at a hillside of soft rock; they formed bowl-shaped craters 25 × 4 ft., and 30 × 6 ft. In the test for rapidity, 5 dummies, loaded to represent 500-lb. shells, were fired in 8 min. 23 sec.; the longest interval between shots being 2 min. The impact and time fuses worked well.

The tests of the Crozier 10-in. wire-wound breech-loading rifle, says the last report of the U. S. Ordnance Board, have been continued during the last year. At the date of the report 231 rounds had been fired, and the test was to be carried to 300 rounds. So far the gun has stood the trials well; the bore shows the usual corrosion due to long-continued firing, but no structural weakness has been developed in the weapon. The report deals with the satisfactory development in gun-carriages, both of the disappearing and front pintle type. The Crozier-Buffington 8-in. and 10-in. carriages have passed the experimental stage and have been adopted, and the carriages for the 12-in. rifled mortars have been tested with most excellent results,and with their guns they have proved formidable in defensive works. In tests for the rapid firing of heavy guns the following record is presented: Non-disappearing barbette carriage and 8-in. gun, 10 rounds in 17 minutes; same carriage with 10-in. gun, 10 rounds in 14m. 39s.; with 12-in. gun, 10 rounds in 28m. 11s. With a Crozier-Buffington disappearing carriage, an 8-in. gun fired 10 rounds in 12m. 22s.; a 10 in. gun, 10 rounds in 14m. 41s., and a 10 in. gun on a Gordon carriage was fired 10 times in 18m. 45s. The test of high explosives fired directly from heavy guns has been continued under the direction of Gen. H. L. Abbott, Corps of Engineers. A shell containing 114¼ lbs. of gun cotton, with 58 lbs. of paraffin and Canada wax to fill the interstices of the gun cotton, was safely fired from a 15-in. gun rifled for these experiments. The propelling charge was 123 lbs. of powder, the elevation 21° and the velocity was about 960 ft. per second. The same gun was then loaded with a shell containing 230 lbs. of Emmensite, with the same powder charge and elevation as before, and the loaded shell weighing 1,640 lbs. This charge burst the gun into fragments. The Board has bought the right to use Emmensite, and will continue its experiments in order to determine what charge of this material can be safely used, and also to test the claim of the inventor that the sensitiveness of the composition can be diminished by changing the proportions. The Board concludes its report by saying that while coast defense work is progressing on a sound basis, this progress is at too slow a rate. The Board asks for $2,000,000 for the construction of emplacements, etc., and $5,000,000 for guns mortars, carriages and ammunition.

A bill for the better equipment of the militia of the several states is to be presented to Congress, with the warm approval of the Secretary of War. As the newly adopted Krag-Jorgensen rifle is being issued to the U. S. Army, a large quantity of the Springfield rifles of 45 calibre are now stored in the national arsenals. The bill would authorize the Secretary of War to issue these latter guns to the state militia, and do away with the present variety of weapons, requiring different kinds of ammunition, now in the hands of the state troops. The bill is in accord with requests long ago made by the authorities of a number of the states.

A new aluminum work is reported in an article going the rounds of the press, to be approaching completion at Fairlawn, near St. Louis, Mo. The concern is called the American Aluminum Company, organized with a capital of $1,000,000, and it proposes to turn out 20,000 lbs. of aluminum every 24 hours. As the total output of aluminum in the United States in 1895 was only about 850,000 lbs., or about 2,800 lbs. per day, counting 300 working days in the year, we think the new concern will have difficulty in obtaining a market for its large product. Projected aluminum companies which made large promises and no aluminum have been quite frequent during the last few years, and the concern now mentioned may be one of the same kind.

Natural gas was discovered in Indiana in 1886. The first annual report of the State Natural Gas Inspector, a newly created office, is a voluminous one, and shows a very perceptible diminution of the gas supply over the entire field of an original area of 2,500 sq. miles. The original rock pressure of the gas was 325 lbs. per sq. inch; after nine years' development this has been reduced to 230 lbs., and it is pointed out that the future decrease will be at a more rapid rate, though the amount wasted is growing less. As a rule these wells are drowned out when the pressure falls below 200 lbs. though a few wells flow gas at 50 lbs. pressure. Inspector Leach says that the question of supreme importance at this time is the economical use of natural gas, as many millions of dollars and about 20,000 workmen have been attracted to this gas belt, in the last nine years by this inexpensive fuel.

A national sanitary experiment station is recommended by Prof. G. H. Hurd, Chemist of the District of Columbia. Such a station, he contends, would promote sanitary science and serve as an educator to the various departments of health throughout the country and to the public generally. The subjects to be investigated would be various common diseases, about which much is yet to be learned, and the improvement of water supply, sewerage systems, ventilation, heating and lighting.

BOOK REVIEWS.

AMERICAN STEAM AND HOT WATER PRACTICE From "The Engineering Record." Being a selected Reprint of Descriptive Articles, Questions and Answers. New York: "The Engineering Record." Cloth, 4to., pp. 317, 585 illustrations; $4.

"The Engineering Record" has for many years made its department of Steam and Hot Water Heating and Ventilation a prominent feature, and the volume now before us contains a reprint of numerous articles which have appeared in its columns since 1888, including illustrated descriptions of hot-water, steam-heating and ventilating installations in different classes of buildings, besides a collection of questions and answers on problems arising in this department of building engineering. The book contains a great variety of useful information conveniently arranged, and may be commended especially to heating and ventilating engineers and to architects.

THE PRACTICAL APPLICATION OF DYNAMO ELECTRIC MACHINERY. By Carl K. MacFadden, M. Am. Inst. E. E., and William D. Ray, Vice-Pres. Chicago Electrical Association, Chicago. Laird & Lee. 16mo; cloth; pp., 167. $1.

There is a great demand for "a first book" on electricity, for the use of engine drivers, dynamo tenders, and others, and there is also a plentiful supply of such books. The little one before us is about as good as any one of the kind that we have seen. It treats of units of electrical measurement, Ohm's law, magnetism and induction, theory of dynamos, current distribution, transformers, types of dynamos, causes of trouble in dynamos, arc lamps, electric motors, storage batteries, electric heating, etc. The paper and print are cheap looking, and we think the publishers might have produced a better looking book for the price charged, and given the subject matter a dress which its merit deserves.

THE YELLOWSTONE NATIONAL PARK. Historical and descriptive. Illustrated with maps, views and portraits. By Hiram Martin Chittenden, Captain, Corps of Engineers, U. S. A. Cincinnati. Robert Clarke C., 8vo, pp. 397. $1.50.

Capt. Chittenden, in this volume, pleasingly condenses a large amount of scattered information relating to the history and the natural features of this wonderful national park. While the Yellowstone region was properly explored and its contents described only 25 years ago, by Folsom and Cook and their immediate followers, Yellowstone Lake was discovered by John Coulter, one of the Lewis and Clarke party, in 1807, and by James Bridger, in 1824. The work before us traces out the history of the Yellowstone region with its Indian campaigns, and the early geological and topographical explorations within its borders to its final conversion into a national reservation. Separate chapters deal of administration; history of the park; its boundaries and topography; geology, geysers, fauna and flora, etc. A tour of the park is made and its many wonderful natural features are shown photographically and by maps. A voluminous appendix enters into minute detail concerning some of the features of this park, its explorers, legislation, appropriations for and bibliography of the Yellowstone region.

THE JOURNAL OF THE IRON AND STEEL INSTITUTE. VOL. XLVII. Edited by Bennett H. Brough. Secy., E. & F. N. Spon, London and New York. Cloth 8 vo.; pp. 571.

The present volume will sustain the reputation hitherto held by the Journal, of being the most important publication devoted to the iron and steel interests in the English language. About three-fifths of the volume is taken up by the proceedings of the London meeting held in May, 1895, and the remainder contains notes on the progress of the British and foreign iron and steel industry, consisting of brief abstracts from several publications, and forming practically a condensation of the technical history of the industry for the year 1894. The address of the President, Mr. David Dale, is a notable paper of the statistical and economical order, which it will pay economists to study. It contains the best series of statistical diagrams relating to the iron and steel production of the world that we have ever seen, and treats in no optimistic way of the decadent state of the manufacturing industries of Great Britain. The technical papers are as follows: On "Metal Mixers," by Arthur Cooper; on "The Effect of Arsenic on Steel," by J. E. Stead; on "The Mines of Elta," by Herbert Scott; on "The Manufacture of Steel Projectiles in Russia," by Serguis Kern; on "Ternary Alloys of Iron with Chromium, Molybdenum and Tungsten," by James S. De Benneville.

ROPE-DRIVING.—A Treatise on the Transmission of Power by Means of Fibrous Ropes. By John J. Flather, Professor of Mechanical Engineering in Purdue University, Lafayette, Ind. New York: John Wiley & Sons. Cloth: 12mo.; pp. 230; $2.

The use of cotton and manilla ropes as a substitute for toothed gearing and for belts has become quite common during the last ten or fifteen years, and there has been considerable matter on the subject published from time to time in the transactions of engineering societies and in technical journals, but it is only recently that one or two books upon the subject have appeared. Prof. Flather is to be congratulated upon the thoroughly admirable manner in which he has accomplished his task in the work before us. He has condensed into this small volume practically all the matter of importance on the subject that has been published anywhere, giving full credit to his sources of information, and has made a book that will be simply indispensable to any one not already an expert on the subject who wishes to post himself on the theory and practice of rope-driving, to determine whether or not a rope drive should be used in any particular case, or to design a rope-driving system. A complete exposition of the theory is given, and numerous examples from practice are described and illustrated. The ideas are expressed with clearness, and the make-up of the book is all that can be desired. In quite a complete examination of the book we have found only two trifling points which may be criticised. On p. 51 the meaning of the term "arc of contact (circular measure)" should be clearly explained, as is partially done on p. 114. On p. 60 the expression $0.0^{6}d^{2}Lv$ is used, the .0⁶ being a term which will be like so much Greek to a majority of readers until they discover by calculation of the preceding expression that it means 0.000006. There seems to be no good reason for not using the latter form. We do not see why chapter headings are not given under the chapters, as they are in the table of contents, and why the odd-numbered pages are not given these headings instead of the uniform heading "Rope-Driving."

LETTERING FOR DRAFTSMEN, ENGINEERS AND STUDENTS: A Practical System of Freehand Lettering for Working Drawings. By Chas. W. Reinhardt, Chief Draftsman, Engineering News, New York. D. Van Nostrand Co. Oblong 8 vo.; cloth; pp. 22; 9 plates; $1.

With the practical application of the principles laid down in this work our readers are familiar, through the work of the author upon the illustrations and drawings appearing in this journal. The book is mainly devoted to a thorough description of a particular type of lettering which is especially adapted to rapid freehand work and to the requirements of photo-mechanical reproductions. One of its especially valuable features is its exhibits of the correct and incorrect methods of "single stroke lettering," in which is pointed out, from the experience of a draftsman of long training, the pitfalls which entrap the novice and the means of avoiding them. The proportioning and spacing of large and small letters are not gone into with much detail, and examples of the proportioning and spacing which are shown, drawn on a basis of equal squares, with equal spaces between them, may be severely criticised. But in the lettering and numerals on working drawing, their arrangement, spacing, etc., the author again gives most excellent advice, based upon long practical experience. The one purpose intended throughout is the teaching of freehand, single stroke lettering, pleasing in general effect and rapid in execution; and in this Mr. Reinhardt has well succeeded. His disposition of letters and figures on maps and upon working drawings is worthy of the closest study, and should be correspondingly useful to the student and draftsman. Confusion, bad proportion and bad arrangement in lettering are among the most common faults in this class of drawings, and they are faults that the most carefully executed individual letters and figures will not correct. We criticized the book on a similar topic received above for the absence of title on the front cover; we have to find fault with the existence of the title on the one now being described. A plain example of good upright pure gothic lettering would have been much more suitable than the elaborate composition of curved and shaded letters which is used.

THE METALLURGY OF IRON AND STEEL. By Thomas Turner, Associate of the Royal School of Mines. Edited by Prof. W. C. Roberts-Austen, C. B., F. R. S. Vol. 1. The Metallurgy of Iron, with Numerous Illustrations. London, Charles Griffin & Co.; Philadelphia, J. B. Lippincott Co. Cloth, 8vo.; pp. 367; $5.

This book is stated to be one of a series of volumes written by the associates of the Royal School of Mines and edited by Prof. Roberts-Austen. It is not a merely elementary text book on the one hand, nor an exhaustive treatise on the other. It is primarily intended for persons who are connected with the manufacture of iron and steel, and who may therefore be assumed to have already some general knowledge of the subjects discussed. The history of the manufacture of iron and steel is treated more fully than is usual in metallurgical treatises. The portions dealing with foundry practice and with the reactions of the puddling furnaces have been treated in greater detail than usual. A special chapter has been devoted to the corrosion of iron and steel. The above items are gleaned from the preface. It is many years since a really good work has been published on the metallurgy of iron, and since Percy's "Metallurgy of Iron" appeared in 1864 there has been no book on the subject which at all approaches that famous work in merit. Percy is now out of print, and is far behind the age. The present work, while inferior to Percy in many respects, is approximately up to date, and is probably as good as any other book on the subject of which it treats, for the student and for those connected with iron works. It does not treat at all of the metallurgy of steel, except in a brief historical sketch covering only 13 pages. This subject is probably left to be treated in a separate volume.

Taking up in detail the contents of the volume, the first 48 pages are devoted to the history of iron manufacture, then follow two chapters on iron ores and their preparation, five chapters, covering about 100 pages, on the blast furnace, a chapter on the properties of cast-iron, another on foundry practice, four on wrought iron, including both direct and indirect processes, puddling and rolling, and a final chapter on corrosion of wrought iron and steel. The work is essentially a compilation, full credit being given to the original source of information, with copious references. It is evidently the production of a book-maker and not of one practically experienced in iron manufacture. The practice described is chiefly European, although some references to American practice are also given. The style is labored, and the treatment of many of the subjects is entirely too brief and fragmentary. If some one of our American metallurgists would devote himself to the task, we have no doubt a much better book than the one before us might be produced, but since they all appear to be too busy for book-making we will have to be satisfied with this English work

THE INTELLECTUAL RISE IN ELECTRICITY. A History. By Park Benjamin, Ph. D., LL. B. New York: D. Appleton & Co. 8vo; cloth; pp. 611; illustrated; $4.

Mr. Benjamin here traces back to the very dawn of history the recognition by man of that natural force called electricity. In a most interesting manner, and as the result of much painstaking research, he tells us the legends to which these unaccountable phenomena naturally gave rise, and follows the development of electrical science through all ages and nations up to the time of our own practical investigator—Benjamin Franklin. According to Mr. Benjamin, the first intelligent observation of an electrical effect was probably connected with the use of an amber spindle, which as it whirled around rubbed against the loose garments and became electrified. Pliny says that the Syrian women called amber "harpaga," or "the clutcher," from the observed fact that as a spindle of this material neared the ground it often drew to itself dust or bits of leaves and attracted the fringe of their dress or other loose filaments. While the name "electron," first given to amber, arose from its assumed resemblance to a sunbeam, its use as a spindle apparently first called attention to its peculiar properties. The property of attraction in both amber and the lodestone was noted by Theophrastus, as early as 287 B. C., in his treatise on "the stones and earths," and little was added to the knowledge of that early date for the next fourteen or fifteen centuries. As to the origin of the magnetic compass, Mr. Benjamin denies the Chinese claim as improbable, and not in accordance with Chinese history and their known inefficiency as sailors and astronomers. Contemporary evidence points to a Finnish origin for this aid to navigation. The laws of Wisbuy, governing rights on the high seas, and promulgated prior to the 12th century, imposed especial and severe penalties upon any one tampering with or falsifying the compass. The compass was not used on Spanish ships until 1403.

After passing in review the legends and myths of preceding ages, Mr. Benjamin next separately takes up the several investigators into electrical phenomena, commencing with Roger Bacon, and gradually advancing to William Gilbert, born in 1540, who, through a marvelous originality of thought, first sought to establish physical science on a philosophic basis. After Gilbert came Francis Bacon, Galileo, Digby, Sir Thomas Browne, Otto von Guericke and a rapidly-widening band of scientists, both in England and on the Continent. The electrical experiments of Watson, about 1746, awakened the interest of Franklin in the development of the theory of electrical phenomena, and Mr. Benjamin devotes his final chapter to detailing the progress made by the American philosopher, in connection with similar investigation by English and French experimenters. The author concludes by saying that when the identity of lightning and electricity was established by the kite experiment of Franklin, the wise men deemed that all was known, and the end had come. But the book had only been opened; we have read very much from it since, and we shall, as our knowledge grows, continue to read on.

COMPRESSED AIR.—Practical Information upon Air-Compression and the Transmission and Application of Compressed Air. By Frank Richards, M. Am. Soc. M. E. New York: John Wiley & Sons. Cloth, 12mo,. $1.25.

This little book is largely a reprint of articles which have appeared at intervals during the last two years in the columns of the "American Machinist." There has hitherto been a notable lack of easily accessible printed matter on the subject of compressed air, and the appearance of this book will be welcomed by a large class of readers. The author has had a variety of

experience with air compressors, and is not a professional book-writer. His style is that of an occasional correspondent of a mechanical journal, and while he conveys a great amount of useful information, some of his statements lack precision, and his judgment in many cases is open to dispute. Nevertheless, there is so much that is good in the book that we gladly commend it to all who wish to read up on the subject of compressed air, while we advise that allowance be made for some of its conclusions.

The author seems to have a grudge against the builders of air compressors, which he generally condemns for lack of efficiency. We quote a few paragraphs to show his feelings on this matter, and also his literary style:—

"While there is no compressor builder, that I know of, who is now offering a compressor furnished with injecting pumps, there is no objection to builders retaining in their catalogues, as they do at this writing, the standard arguments against the injection system, because it helps to give the catalogue a formidable appearance, you know, and no one is harmed by the practice.

"The arrangements of the tandem, single-acting, two-stage compressing cylinders is about as bad a one as could be devised for an air compressor, and no possible change in the relative capacities of the two cylinders can make it right.

"In the case that we are now considering, where the air is delivered from the compressor at a pressure of 35 lbs., the first cylinder happens to do all of the work of compression, and none of the work of expulsion or delivery."

The statement made in the last paragraph is certainly erroneous. If the piston of the cylinder pushes any of the air out of the cylinder against the pressure existing in the passage between the two cylinders it cannot help doing work of delivery as well as of compression.

"It is safe to say that the ultimate efficiency (of air compression) never goes as high as 80%, while it often goes below 60%. If any air compressor builder feels aggrieved over this statement, a fine opportunity is opened for a demonstration of a higher efficiency.

"The principal thing to be said of the up-to-date compressor is that it is not up to date. * * * The catalogues of air-compressor manufacturers are interesting in this connection, and the alleged indicator diagrams contained in them are worthy of study. I have learned from them, if nothing more, to respect the wisdom of the builder who does not allow the diagrams from his steam and air compressing cylinders to be seen. * * * We may say that the air compressor makers are living upon the ignorance of their customers, or we may say that the blind are leading the blind, as may seem most correct for the individual case.

"The full sponsorial and patronymic appellation of the most pretentious member of the air-compressor family is the Corliss Cross-Compound Condensing Compressor. It may be called the five C's. The Cross is not practically as good as the tandem, but commercially the alliterative feature is valuable. The Corliss feature is one of the most valuable adjuncts for selling the compressor, but has nothing to do with operating it."

The challenge thus thrown down to the compressor builders, they will probably pass by as unworthy of their notice, but at the same time engineers who are interested in what air compressors may do would be glad to see Mr. Richards's charges refuted if they can be. In fact, we feel certain that they can, and that a better compressor has not yet been built than the one with the alliterative name which Mr. Richards esteems so lightly.

A TEXT-BOOK ON PLAIN LETTERING. By Henry S. Jacoby, Associate Professor of Civil Engineering in Cornell University; the Engineering News Publishing Co. Oblong, 8vo., 82 pp. of text with illustrations and 48 plates. $3.

This text-book is intended as a guide to the detailed treatment of Roman, Gothic and some other kinds of plain letters suitable for engineering and architectural drawings. Prof. Jacoby has, evidently, made a careful study of this subject, and, aside from the excellent examples given in his plates, the great value of this work lies in his definite system of proportioning and spacing letters, the same scale being used for both. While the importance of proper proportion and spacing has long been recognized, we believe this is the first attempt to reduce these elements to a well-worked-out system. In the separate treatment of rectangular, diagonal and curved letters, the text is very full and clear and the illustrations of principles numerous and beautifully executed by the author. Prof Jacoby takes up in detail, Roman and Gothic capitals and small type, with a brief description of French and Roman old styles, stump writing, numerals, etc. A special chapter is devoted to spacing, which, if not properly attended to, will destroy the pleasing effect of the most carefully constructed letters. In this chapter the line of reasoning, leading to the conclusions adopted and to the rules and tables laid down by the author, is plainly set forth. Word spacing is included in this treatment. Another chapter then discusses the selection, arrangement, position and proportioning of titles, of which a large number of approved examples are given in the plates. Included in this chapter are the standards of the U. S. Coast and Geodetic Survey and the Geological Survey. He also gives advice and directions upon the requirements of lettering Patent Office, architectural and engineering drawings, maps, tracings for blue-printing, and for photo-mechanical reproduction. Directions are also briefly given for free-hand lettering. A final chapter treats of mechanical aids to lettering, in which the "lettering triangles" frequently used for this purpose are shown to give very unsatisfactory results; the exception made by Prof. Jacoby being in favor of a type known of as Keenan or Kelsey's combination triang.e, which has certain advantages in manipulation. The general guidance given in what constitutes proper proportion, spacing and selection of letters must have great value and the rules laid down are applicable to rapid freehand, as well as to more painstaking work. The plates that follow the text are simply invaluable to any draughtsman. In the first eight plates, the construction of plain, Roman and Gothic letters and figures and of important modifications of these types are shown in detail and with perfect clearness. Three plates are devoted to rules and studies of spacing; six to examples of titles; ten to the standards of the U. S. Coast and Geodetic Surveys, the U. S. Geological Survey, the U. S. Engineers Office, and the Mississippi River Commission. Three plates show samples of scales, meridians and borders; five show examples of fine map work (one being made especially for this work by Mr. Edward Molitor, Top. Engr.); and eight plates give specimens of different type alphabets suitable for engineering or architectural drawings.

On the whole, the appearance of the book is very satisfactory. The printing of some of the figures in the text and of part of the plates is not quite what it should be in a work of this character, and the title of the book should appear on the side as well as the back, but these are faults that will doubtless be remedied in future editions.

CENTRIFUGAL PUMPS. An essay on their construction and operation, and some account of their origin and development in this and other countries. By John Richards, San Francisco. The Industrial Publishing Co. Cloth: 8vo.; pp. 68. $1.

This is an important contribution to the literature of a subject upon which very little of value has been written. The character of the book may be judged to some extent from its first two sentences, which are as follows:

"The essay to follow will be a peculiar one in some respects; a technical subject dealt with empirically, and in many cases by controversion of assumed data respecting centrifugal pumps, perhaps unmistakably now and then, but in all cases from observation and actual experience in designing, constructing and operating such pumps. These pumps are a class of machines 'sui generis,' that defy the mathematician, and, as an old workman once remarked to the writer, 'have more tricks than a circus mule.'"

The author treats to some extent upon the practical considerations entering into the design of centrifugal pumps, and has an interesting history of their development since the time of the Massachusetts pump of 1818. He claims that the centrifugal pump is purely an American invention, and severely criticises some writers who have held it to be of European origin. An appendix contains several communications from engineers and makers of centrifugal pumping machinery on the Pacific coast, giving considerable data of experiments and other valuable practical information. It is to be regretted that the book is a collection of fragmentary articles on centrifugal pumps, instead of being a formal treatise, such as is greatly needed by engineers, and that Mr. Richards is apparently weak in his grasp of the theory of centrifugal pumps, which practically disqualifies him from writing a treatise. As an example of this weakness we quote the following, from page 6:

"The speed of the periphery of an impeller is governed by the law of acceleration for falling bodies, $v=\sqrt{2gH}$, or, expressed in feet per second, 8.02 times the square root of the head. The circumferential velocity will raise a column of water to the assumed head, but the additional pressure required for discharge or 'flow' must be added, so it is common to estimate the velocity of impellers about 20% more or $10\sqrt{H}$ (20% more is $9.63\sqrt{H}$—Ed.) which answers as a general rule, although the result is modified by the form of the vanes and the depth or width of the discharge chamber beyond the vane tips."

On pages 27 he quotes a communication from Mr. Charles Brown, of Sulzer Bros., Winterthur, Switzerland, to "Engineering," of London, in which it is shown that a pump having a vane curved forward held water without any discharge at a height when the velocity of the tips was only $0.82 \times \sqrt{2gH}$, but Mr. Richards makes no explanation of how it is possible to obtain this result with less than the so-called theoretical velocity, $v=\sqrt{2gH}$. Since some of the work done by the revolving vanes must be expended in overcoming frictional resistances in the pump itself, it would appear that the velocity needed to sustain the head H would be considerably more than $\sqrt{2gH}$ instead of only $0.82\sqrt{2gH}$.

The trouble is that Mr. Richards does not appreciate that the formula $v=\sqrt{2gH}$ is entirely wrong for centrifugal pumps, and that the correct theoretical formula, friction and head required for flow being neglected is $v=\sqrt{gH}$ or $v=0.707\sqrt{2gH}$. It is the same formula as the one that applies to windmills, and fan blowers, and is similar to the formula for reaction of a jet, R=2H, that is the pressure or reaction of a jet is twice that due to the head supplying the jet. For proof see Church's "Mechanics of Engineering," p. 798; Coxe's "Weisbach," p. 1003, and Wolff's "Windmills," p. 17. The actual velocity of the tips should be greater than $0.707\sqrt{2gH}$ to overcome friction and to create flow, and the result of Mr. Brown's pump, sustaining a head with $v=0.82\sqrt{2gH}$ is what might be expected from a good pump, instead of being impossible, as it would if Mr. Richards' formula, $v=\sqrt{2gH}$ were correct. Notwithstanding these defects of the book, however, it is one which no one interested in the subject can afford to neglect, for it contains a quantity of practical data which it would be difficult to obtain elsewhere.

PRACTICAL ELECTRICAL ENGINEERING. A Complete Treatise on the Construction and Management of Electrical Apparatus as used in Electric Lighting, and the Electric Transmission of Power. Illustrations. By W. W. Beaumont, M. I. C. E., C. H. W. Biggs, M. I. E. E., C. Capito, M. I. E. E., G. Kapp, M. I. E. E., M. H. Kilgour, M. I. E. E., A. Reckenzaun, M. I. E. E., P. Selbon, M. I. E. E., J. Swinburne, M. I. E. E., H. Swan, M. I. E. E. London, Biggs & Co.; 2 vols.; cloth, 4 vo.; pp. 384 and 422; $15.

The names of the authors of this work given above are those found on the title page of the first volume. In the second volume, two of the names, Messrs. Beaumont and Swinburne, are left out, and that of A. T. Niblett, C. E., is added. The second volume also has the imprint of J. Arnot Penman, 7 Warren St., New York, in addition to that of Biggs & Co., London. Whatever may be the merits of this work, the method of constructing it is entirely reprehensible. It was got up originally as a subscription book, issued in unbound monthly parts. It has apparently ten different authors, but with the exception of the portion on dynamos, alternators and transformers, by Gisbert Kapp, there is nothing to show which one of the authors is responsible for any of the chapters. In the introduction the work professes to have for its object the giving of "plain information by practical men to practical men," yet a large portion of the work is highly theoretical and full of mathematics. The different authors have different styles; some write in a popular manner, and others in the manner of the differential calculus. There is no logical order in the arrangement of subjects, no proper balancing of the space given to different departments—some are overdone, others underdone—and there are no tables of contents. One has to turn over the pages of the two volumes in order to learn what are the subjects of the chapters. This we have done, and the following is a list of the principal titles, with the number of pages devoted to each: Introduction, General Principles, The Conductive Circuit, Chaps. I and II, 22 pp. III. The Magnetic Circuit, 7 pp. IV. The Inductive Circuit, 4 pp. V. Electro-Graphics, 10 pp. VI. The Central Station, 1 p. of text, with 3 of illustrations. VII. Foundations Considered Practically, 13 pp. VIII. Steam Boilers, 92 pp. (chiefly about English styles of boiler). IX. Principles of Dynamics, 9 pp. (including an account of the planimeter). X. Heat, 11 pp. (a part of this relates to Thermodynamics of Imaginary Gases. The relation of this to practical electrical engineering is probably "imaginary"). XI. Theory of Steam Engines, 33 pp., of which the greater portion treats of steam engine indicators. XII. Details of Steam Engines, 55 pp. A large part of this chapter is devoted to design of engine parts, useful to an engine builder, but having no interest to an electrical engineer. Two pages are devoted to a "barring engine," used for turning a large single cylinder engine over the center if it should get "stuck on the center." XIII. Switches and Switchboards, 27 pp. XIV. Measurements. 61 pp. XV. Electric Light Mains, 32 pp.

So much for the first volume. The second is not divided into consecutively numbered chapters, but into books or parts without any distinguishing number. The first is entitled Dynamos, Alternators and Transformers, by Gisbert Kapp. It has 14 chapters and 96 pp. Then follow Secondary Batteries, 4 chapters, 77 pp.; Design in Conductors for Distribution, 63 pp.; Electric Transmission, 7 chapters, 120 pp. (This part of the book should have been headed Electric Traction, for it is nearly all devoted to street car motors, etc., and not at all to transmission of electric power in general). Incandescent Lamps, 45 pp. and Arc Lamps, 13 pp.

Each of the volumes has its own alphabetical index, so if we wish to find any subject we suspect to be in either, we may have to look in both indexes before we find it. The different portions of the book are, as might be expected, of varied merit. Mr. Kapp's work on "Dynamos, Alternators and Transformers" is especially good, as are also the chapters on Secondary Batteries. Those portions that pertain rather to mechanical than to electrical engineering, such as the chapters on Heat, Steam Boilers and Steam Engines are very poor, and the book would have been much better if the space given to these subjects had been saved. The whole work shows that it has been "got up" by the publisher to sell by subscription, and it is not creditable to the judgment of those eminent electricians whose names appear on the title page but are not found in the body of the text, so that their work may be identified, that they have allowed their work to be buried in these volumes. It is to be hoped that engineering authors and book buyers will hereafter discourage the production of subscription books like the one before us, which is neither a cyclopaedia nor a treatise, and for which there is no real demand.